



Editorial

THE Federal Budget has made radio a much more expensive business than ever before.

Radio sets and components now carry a sales tax of 33 1-3 pc and the licence fee has been increased to £2 per year.

The best thing anyone can say of these increases is that if the principle must be accepted that our taxes must be increased we cannot expect radio to be completely exempt. But in our view,

the previous tax of 25 pc was as high as the radio industry should have been asked to carry at the present time.

It is difficult to understand apparent contradictions in the assessment of the radio industry. Everyone agrees that it is immensely valuable both in peace and war. In peace, radio is a necessity for any modern family, rich or poor. Therefore we should have a steady flow of radio sets from a stable industry to a public which can afford to buy. In wartime we won't have enough facilities to provide all the radio equipment we want. The harder the job of the radio industry in peacetime, the less prepared it will be for possible war.

There's little doubt that the high sales tax on radio will impose heavy loads on the industry—a load it should not have been asked to carry.

With the increase in the licence fee it is easier to be reconciled. Admitting that a National broadcasting organisation is a necessity, then adequate revenue must be provided for it. The licence method is probably the only way to the revenue to listening which can be administered adequately.

Removing the need for extra licences for extra sets isn't as philanthropic as it sounds. The idea was logical, but almost impossible to police. It is safe to say that very few paid the extra fee, or could be successfully detected if they did not. We don't feel that the PMG is losing anything by it.

Thus our main objection is lodged against the idea that the radio trade is an appropriate field for tax exploitation. It is not—it is a complicated field of operation and research which costs quite enough money as it is.

Research alone is probably the costliest and most vital. During the next few years we will see sweeping developments, such as pulse modulation, which may well revolutionise communication and broadcasting. No encouragement which the Government can give will be too great.

John Moyle

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RADIO

AND HOBBIES IN AUSTRALIA

A NATIONAL MAGAZINE OF RADIO, HOBBIES AND POPULAR SCIENCE

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Vol. 13

No. 8

SUBSCRIPTION RATES

C'wealth, NZ, N. Guinea, Fiji—18/- pa.
United Kingdom — £1/2/6 pa.
B. Empire — £1/3/- pa.
Foreign — £1/5/- pa.

Published on the first Friday of
each month by Associated News-
papers Ltd., 60-70 Elizabeth St.,
Sydney.

Phone BO333

OUR COVER PICTURE

Our Cover Picture—Made
by a master English toy-
maker, this model helicop-
ter shows a British airman
what it can do—See story
on page 23.

Palec Power Analyser

reveals **ELECTRICAL ENEMY No. 1**

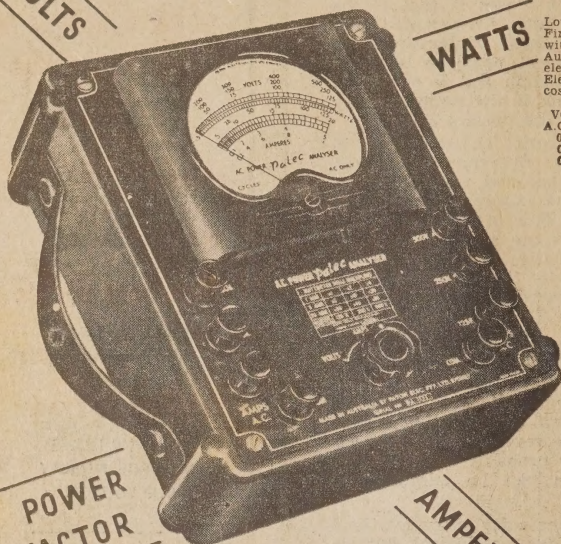
LOW POWER FACTOR

VOLTS

WATTS

POWER FACTOR

AMPERES



Low Power Factor is Electrical Enemy No. 1. Find and correct this costly electrical waste with the Palec A.C. Power Analyser, Model PA, Australia's first dynamometer multi-meter, for electrical service, maintenance and testing. Electrically efficiently utilised could save the cost of this instrument many times over.

VOLTS	AMPERES	WATTS
A.C.-D.C.	A.C.	A.C.
0-125	0-1	0-10,000
0-250	0-5	9 ranges of watts
0-500	0-20	3 for each voltage range

ACCURACY: Effects of wave form, power factor, voltage, current and frequency variations are negligible.

The Palec A.C. Power Analyser incorporates a true dynamometer movement of the nickel-iron cored type. There are no rectifiers or non-linear resistance included, nor is it necessary to compensate for line voltage in wattmeter readings.

APPLICATIONS: Industrial maintenance, production testing, laboratory work. Particularly suitable for testing and servicing refrigerators and other motorised appliances. D.C. as well as A.C. voltage may be measured.

EXTRAS: Leatherette-covered carrying case, external resistance box for 3-phase testing, Current and potential transformers for extending ranges supplied at extra charge.

DIMENSIONS: The Palec Power Analyser is housed in an exclusive semi-hard rubber case, size 8 inches by 9 $\frac{1}{2}$ inches by 4 $\frac{1}{2}$ inches overall. Weight, 8 lbs. Price on application.

Palec M.30 MULTIMETER

Model M.30—new 30-range multi-meter—is indispensable for modern radio and electrical technique.

Ranges—

D.C. Volts: 0-0.1, -3, -10, -30, -100, -300, -1,000.

A.C. Volts: 0-3, -10, -30, -100, -300, -1,000.

D.C. Milliamps: 0-0.3, -1, -3, -10, -30, -100, -300, -1,000.

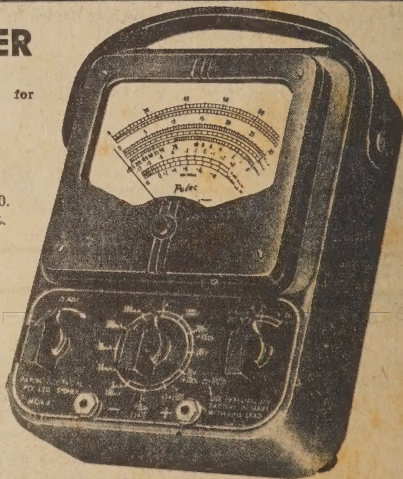
Ohms: 0-10,000 and 0-1 megohm with internal Batt.

0-10 megohms with external Batt.

Decibels (a) Zero reference level = 6 milliwatts in 600 ohms: -17 to +3: +3 to +23: +23 to +43.

(b) Zero reference level = 1 milliwatt in 600 ohms: -10 to +10: +10 to +30: +30 to +50.

Other features: Meter scale, 4"; all measurements from two terminals only; bakelite housing; test leads supplied. Accuracy; reliability; low costs. Price on application.



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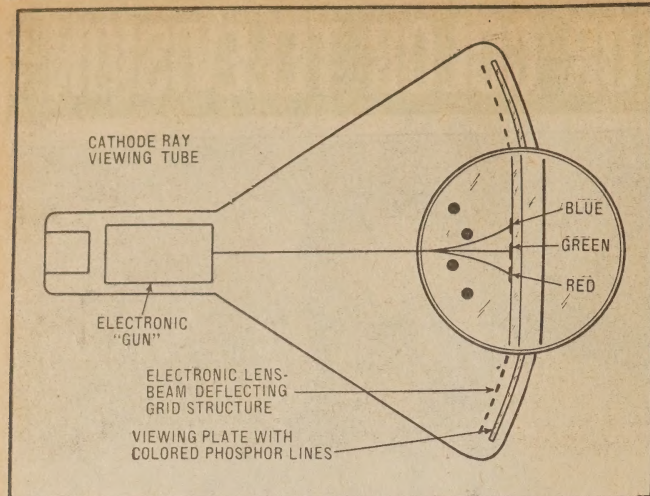
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RCA TUBES FOR COLOR TELEVISION



IN America, RCA has greatly improved its CRO tube for color TV. Here we see Dr. E. W. Engstrom, vice-president in charge of research, RCA, with a model of the 16in. tri-color picture tube, with 21in tube in the foreground. But a new color tube just announced threatens to do the job just as well and at lower cost. (See story on next page).



Although no diagrams have so far been released giving details of the tube, this simplified diagram shows how the scanning beam can be deflected near the screen to scan the three-colored phosphor lines which make up each color "cell."

A New J.V. Color Tube

Through all the wrangling over color TV in America, nobody really believed that an ideal solution had been put forward. The announcement of a new cathode-ray tube which actually embodies the advantages of both systems in the controversy is likely to have a profound effect on future plans. At best it points to that simpler way which must be found if color TV is to be universally acceptable. In this article, Jack Yoemans, of our New York office, tells about the new tube.

HAVING split the color television industry of America with atomic zest right down the middle, Professor Ernest Lawrence has now gone back to California.

Lawrence, who is by occupation Professor of Physics at the University of California, was the first man to make a workable atom-splitting machine, now called a cyclotron. For this and other work he won a Nobel Prize in 1939.

FIRST CHEAP TUBE

In September, 1951, he ambled into New York (wearing an amiable smile and a faint sun-tan) and demonstrated what may become the first cheap and simple color-television tube. He had invented this much-sought device, he murmured, in his hobby-workshop in the garage of his house near Berkeley, having given the problem an odd hour or two's thought at night when he wasn't busy with his research into nuclear physics.

The color-television atmosphere in America was already tense enough without that. Two huge corporations, the Columbia Broadcasting System

and the Radio Corporation of America, are grappling with each other in a titanic fight to seize the millions of dollars of advertising revenue which will be the prize to the first company which can put a workable, reliable and financially reasonable system of color-television into the American home on any big commercial scale.

CBS won the first round last October. Its scientists produced the whirling-color-disc device which can be attached to the outside of existing television sets using ordinary black and white tubes.

The Federal Communications Commission ruled that this color-wheel could be marketed commercially, cumbersome as it was, because it still seemed better than the self-contained dot-sequential color tube which RCA was putting forward.

With a flurry of injunctions, RCA contested this FCC ruling all the way to the Supreme Court. The court backed up by the FCC in a judgement last May. But RCA refused to give in. It kept on pouring out research-money like water, improving its sneered-at tube and buying huge

advertisements in newspapers all over the country asking people to pick it, experimental color-telecasts on their black and white sets and see for themselves that this was possible.

It is one drawback of the CBS system that a set converted to color cannot get black and white without the nuisance of taking the converter off it—and so far at least all good television programs come in black and white only.

MAY SETTLE QUESTION

Into this tangle Lawrence dropped his tube, which as he demonstrated to a small group of engineers and newspapermen in the Paramount Picture Corporation office in New York on September 19, can be cheaply adapted to receive in color both the CBS programs emitted for color-wheel sets and RCA programs intended for sets fitted with the RCA color tube in place of the ordinary black and white tube.

William L. Lawrence, the New York Times atom-bomb reporter, fittingly assigned to follow up the avocations vagaries of physicist Ernest Lawrence, reported:—

"The new tube promises to bring color television to the home much sooner than expected.

"Professor Lawrence's invention

the outgrowth of his familiarity with the behavior of electrons, promise to settle the controversy that has been raging between rival television manufacturers."

Pointing out that the tube will receive black and white transmissions as well as either CBS or RCA color, Lawrence adds that it would do away with the need for a color-wheel fitted into sets made to pick up the color-wheel transmissions.

An adapter to change scanning rates of the pictures from 60 to 14 a second and three extra valves would be all that was needed.

CONSTRUCTION

No pictures or diagrams of the new tube have yet been released by the New York Times describes construction as follows:—

"The tube is a conventional metal envelope with a single electron gun.

"Inside, within half an inch of the curved viewing screen, is a color viewing glass plate, lined alternately with many phosphor lines in blue, green and red.

"Connected to the plate is a wire grid consisting of multiple electron lenses. This grid is electronically registered with the phosphor color strips.

"The wire grid is a simple electronic lens which serves to deflect electrons to the right color strip on the glass color viewing plate, at a rate equal to the color switching rate of transmission.

"The electronic lens swings the electron beam alternately on the different color strips on the glass viewing screen by shifting the polariza-

of the wires in step with the color switching frequency."

The Times adds that the electrons come out of the electron gun in the base of the tube with an initial voltage of only 4000, instead of being accelerated.

When they reach the wire grid they get an additional 8000 volts, bringing the total to a normal 12,000.

A variation of a few hundred volts plus or minus acts to swing the electron beam in alternation on the color strips.

The Times points out that the Lawrence color tube should have important military uses—it could give color to radar screens thus making the images clearer, a valuable improvement in matters of identifying enemy planes or ships by shape.

The big point which Lawrence (and Laurence) emphasised about the tube was its cheapness. It should, in mass production, cost very little more than an ordinary black and white tube; this cost-saving is, of course, the direct result of the Lawrence tube's simplicity.

CRITICISM

Not everybody is in ecstasies about the tube, though. The Wall St. Journal, for example, went to the demonstration and found the color not as good as that produced by either the RCA color tube or the CBS whirling-disc.

"In some instances," says the Journal, "the various hues had a washed-out look. In others, they lacked sharpness and appeared to over-run each other. Flesh tints were unnatural, too."

"Spokesmen explained that some of these defects were due to the fact that the tube used was a hand-built garage-shop model. They predicted better results from the forthcoming production line models."

Dr. Lawrence, a brown-haired, pleasantly ugly family man aged 50, has wisely said that he started to make his tube with his own hands in his own workshop because his children's incessant questions about How Does Color TV Work, Daddy, had turned his mind to Color TV.

But the professor showed no childish uncertainty when he had made his first tube. He wasted no time in whistling to big business.

TUBES FOR SALE

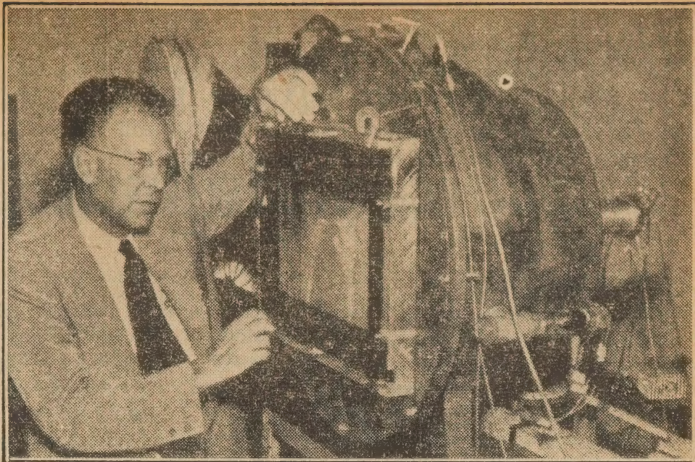
Lawrence, realising that he had a prize in his hands, went to Paramount Pictures, a natural enough thought for anybody living within the Hollywood radiation-field.

Paramount formed a subsidiary (Chromatic Television Laboratories) to help Lawrence make a couple more tubes, mainly by hand (the demonstration tube was in fact the third one made).

Paramount, wasting no time itself, has announced that Chromatic will go into business forthwith making the Lawrence tubes for sale. They will come in two big-screen sizes (16 and 22 inches) and will be made at the subsidiary's newly acquired plant in Connecticut.

Among the unanswered questions now being asked in the trade are, "What royalty will Lawrence draw?" and "Is Chromatic angling for a buy-out bid from some corporation big enough to produce and research on a big scale — somebody like RCA perhaps?"

The Washington Post comments, "The only selling points of the CBS



Dr. Lawrence with his experimental TV color tube.

system are two: it's simple and it works now.

"The new tube could, if it is much simpler than the RCA tube as it seems to be, reinforce the RCA position."

The two giants are glowering silently at themselves and at Dr. Lawrence. They have both let it be known that they want to see the tube as soon as is consistent with dignity.

"Always interested in the latest developments," said an RCA spokesman, doubtless thinking of the money spent in developing RCA's own still-temperamental tube.

"A fine thing if it's everything it's claimed to be," said a CBS spokesman, probably reflecting that, counting lawyers' fees, its own much abused whirling-wheel gadget had cost enough to dress Dr. Lawrence's children in solid platinum suits.

METAL-GLASS JOINTS NOW SOLDERED

Engineers of the General Electric Company have developed a process of soldering glass to metal which, it is reported, makes a bond stronger than the glass itself. The method, which can also be used to solder metal to ceramics and carbon, was originated by scientists of the G-E Research Laboratory, and is currently being tested for industrial applications by the company's General Engineering Laboratory.

The glass and metal areas to be soldered are painted with a thin layer of titanium hydride, and solder is placed upon both painted areas. The parts are placed together and then heated under a vacuum.

When the temperature reaches about 900 F, the titanium hydride decomposes. This causes the solder, which has already become molten, to adhere to the titanium-painted areas of both glass and metal. A strong, tight bond is formed upon cooling.

By using soft metal solders, it is possible to subject this glass-to-metal seal to rapid temperature changes without danger of cracking, despite the wide difference in temperature expansions between glass and metal. This is possible because the differences in movement are absorbed by the solder.

The new technique is now in use in aircraft ignition systems and laboratory investigations have suggested possible applications in the manufacture of transformers, capacitors, and electric motors. These possibilities are now under consideration, according to laboratory engineers.

RUBBER CEMENT

A RUBBER cement called Plastilock, developed by B. F. Goodrich Company, Akron, Ohio, since the end of World War II, is said to be capable of sticking metal to metal with a bond stronger than rivets or nuts and bolts can make.

The new rubber cement was first used to bond brake lining to brake shoes in motor vehicles. Latest model United States fighting aircraft now have brake linings bonded with the new adhesive. Since Plastilock eliminates service life in brake-lining applications, service life of the lining is automatically increased about 75 per cent, it is reported.

Scientists say if petroleum found in rocks of the Palaeozoic and Tertiary periods is the oil we use for illumination today, it probably comes from a source which originated many millions of years ago.

AN ELECTRONIC TIMER FOR LONG TIME DELAYS

USING **Mullard** EF 91

In industrial processes and in domestic equipment there is often a need for a device which will automatically operate a switch after a predetermined time interval of several minutes. Various applications will be apparent to readers. As an example, it may be used in conjunction with an electric toaster to switch off the current before the toast is burnt. An improved timing circuit using only one valve and operating directly from the A.C. mains is described below.

Time-delay circuits employing valves generally belong to one of two groups. In the first of these a simple resistance-capacitance circuit holds off the valve during the timed interval, while in the second the Miller effect is used to retard the rise of anode current in a valve-operated relay circuit.

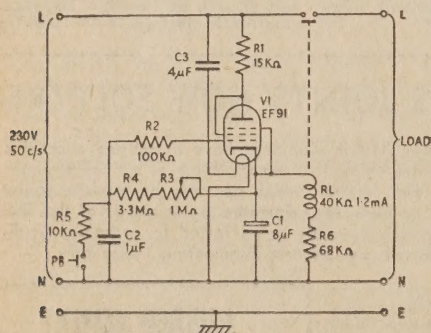


FIG. 1 CIRCUIT OF ELECTRONIC TIMER

Circuits of the first group are generally suitable for time delays up to about $\frac{1}{2}$ minute, since for longer periods the values of capacitance and resistance required become unduly large for most practical applications. On the other hand circuits of the second group can be used for time delays of as much as fifteen minutes without unduly large resistors and capacitors.

A simple time-delay circuit using the Miller feed-back principle is shown in Fig 1. The valve V1 functions as a half-wave rectifier to charge the electrolytic capacitor C1. The rise of potential across C1 is retarded by the feed-back capacitor C2, which is initially uncharged. As the potential across C1 tends to rise, C2 charges through R3 and

R4, pulling the grid of V1 negative and thereby retarding the rate of rise of potential across C1. The effect of retardation is dependent primarily on the values of R3, R4, and C2, and is nearly independent of C1, provided that C1 is large.

The variable resistor R3 provides an adjustment of the time delay. With the component values given, the delay is $1\frac{1}{2}$ to 2 minutes. Much longer delays than this can be obtained by using larger values of C2 and R4.

The relay RL is a high-resistance telephone relay with a low operating current, and is connected in series with a resistor R6 across the capacitor C1. The value of R6 is such that the relay RL closes when the voltage across C1 has risen to about 90 per cent. of its final value. When the circuit is switched on, the first delay period includes the warming-up time of the valve V1. The circuit is reset after each operation by means of the push button PB which is arranged to discharge the capacitor C2.

The heater current for the EF91 is drawn directly from the A.C. supply through the capacitor C3 which is chosen to give 0.3A. With this arrangement one end of the heater must be connected to the neutral line of the A.C. supply. The voltage across capacitor C1 is therefore applied between the heater and cathode of the valve and must not be allowed to rise above the permissible heater-to-cathode voltage of the EF91, namely 150V. Resistance R1 is included in the anode circuit to limit this voltage to a safe value.

The component values in Fig. 1 are typical but some modifications will be necessary for different relays and time delays. Capacitor C1 is electrolytic, C2 and C3 are paper. All resistors are $\frac{1}{2}$ W rating.



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BRITISH COSMIC RAY RESEARCH

Coming out of space and constantly bombarding the higher atmosphere there is a thin rain of charged particles known as the primary cosmic radiation, which are much more energetic than those which can be made in the laboratory with machines such as the cycotrons. Where in the universe do these particles originate and how do they come to be endowed with their great energy?

A NUMBER of widely divergent theories have been put forward but none of them has been generally accepted. It is possible that the answer may lead to the study of some of the fundamental problems in the evolution of the cosmos, and I think that is reasonable to suppose that considerable advances will be made in the next few years.

As a result of investigations extending over more than 30 years we now know the nature of the incoming particles and the most important physical processes which occur as a result of their passage through the atmosphere. The particles are made up of atomic nuclei moving at speeds closely approaching that of light.

Recent experiments prove that hydrogen and helium are the most frequent and the distribution in mass of the heavier nuclei appear to be similar to that of the matter of the universe. Thus elements more massive than iron or nickel occur, if at all, very infrequently. We also know that the particles rarely penetrate to altitudes under 70,000 feet (22.224 kilometres) since by then they have lost their energy in making atomic and nuclear collisions in the atmosphere.

Such collisions can make a variety of changes in the composition of the invading particles—an iron nucleus may, for example, decompose into lighter nuclei such as sulphur; they can even create new forms of matter such as "mesons," of which six varieties have been discovered since 1946 by scientists in the United Kingdom.

RESEARCH AT BRISTOL

American physicists discovered two years ago among the atomic particles coming from out of space the nuclei of elements as heavy as iron (with 26 electrons) as well as hydrogen (with one). Their researches further led them to believe that the lighter elements were much rarer than the heavier ones; and since the proportion of light and heavy elements in cosmic radiation seemed to be similar to their proportion in the sun and in the universe at large, it appeared reasonable to suppose that this cosmic radiation came from the sun or another star.

More recently three research workers at Bristol University, England, developed a new method of assessing those proportions; and discovered a much higher proportion of lighter elements among these space particles. At the moment we in Bristol, with physicists in New York, are trying to find the cause of this discrepancy; if our results are right then it follows that previous speculations on the place of origin, and nature of these space particles did not provide the final answer.

Since the invading particles lose their energy by collision before they

come within about 70,000 feet of the earth, we use balloons, which can maintain a regular flight at a high altitude for considerable periods, to carry the recording equipment, which is automatically sent to earth by parachute. A rocket can pass right through the atmosphere but its time of flight is only a few minutes.

At Bristol we recently launched, by a new method, a balloon 100-feet (30.480 metres) long with an 80-pound (36.287 kilogrammes) lead which attained 88,000 feet (26 kilometres). Signals transmitted by an automatic radio on the balloon were broadcast to listeners in one of our radio programs. The balloons are made of polythelene a plastic material discovered by British chemists, which can be produced in sheets one-

By

C. F. Powell

Professor of Physics, University of Bristol, England. Awarded the 1950 Nobel Prize for Physics.

thousandth of an inch (.0254 millimetres) thick. It is chemically inert and will not perish in the brilliant sunshine above the clouds.

For recording the cosmic particles and the effects they produce we use photographic plates covered with silver bromide emulsion half a milli-

metre thick. The paths of any charged particles which have traversed the emulsion show up, after developing, different kinds of particles producing tracks with differing characteristics.

The plates are attached to the tail of the balloon as they come from the supplier, box, packing and all, simply because many particles can pass right through the lot. (British chemists, incidentally, lead in this particular field of "photographing atoms" and provide physicists all over the world with new emulsions of great sensitivity to record the tracks of all kinds of charged particles.)

After the plates have been processed they are cut into convenient sizes for microscopic examination by some 20 observers, who learn to recognise about 30 different kinds of atomic disintegration.

A new balloon, now being made at Bristol, will be 200ft (60.960 metres) long and have a surface area of some two acres (0.809 hectare). We may have to deal with forces of some tons if the wind rises during its inflation; but we hope that once launched, a flight of at least 115,000ft (35 kilometres) may be obtained.

It is by experiments of this kind that British physicists in Bristol and other laboratories have recently established the existence of heavy mesons, called tau and kappa-particles which are about 1000 times as heavy as the electrons. It seems probable that the study of these particles, which cannot yet be produced by the big machines such as the cyclotrons, will be very important in the near future for our understanding of the atomic nuclei.

WILL THE STEAM CAR RETURN?

THE Persian oil situation has revived interest in a form of road vehicle which preceded the internal combustion engine—the steam car. In the earliest days of motoring most cars were propelled by steam power, but it had a very short vogue after Otto and Daimler between them produced the internal combustion engine.

The great advantage of the steam engine is that it has no need for gears, and further advantages are that it can use cheap liquid fuel such as tar oil or kerosene, it is silent and smooth, has completely automatic control of steam pressure and temperature, it condenses the exhaust steam for re-use, has an explosion-proof type of modern steam generator and a highly efficient engine giving good mileage per gallon.

The starting effort of a reciprocating steam engine is greater than that of any other prime mover and, in fact, is greatest when the engine

is stationary, which makes possible very rapid acceleration without the use of gears or other expensive transmission systems.

LOW ENGINE SPEED

A further important feature of the steam car is that the engine runs at the same speed as the rear axle, or at a slightly higher speed. Even when running at a 25 pc higher speed than the rear axle the engine is normally turning over at only about 900 rpm at 60 mph.

In addition to effortless cruising the lower engine speed makes the engine almost everlasting, and repairs and adjustments are necessary only at very lengthy intervals. For example, attention to the piston rings is necessary only after 30,000 miles. Since there is no exhaust from the engine (the steam being passed back to the condenser which replaces the normal radiator) it is silent at all speeds.—F. J. CAMM in Practical Mechanics.



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SPECIFICATIONS—MODEL X4.

INPUTS, high impedance, gramo, .5 meg., microphone .1 meg.

SENSITIVITY, gramo .25 volt, microphone .002 volt.

POWER OUTPUT, 4 watts. Noise level, —45 db.

DISTORTION, maximum 5% at full output.
OPERATING VOLTAGE, AC 240 volts.
OUTPUT IMPEDANCE, 600 ohms.
VALVES, 2/6AU6, 1/6AQ5, 1/6X4.
DIMENSIONS, 10½" x 7" x 4½".

Specifications—Model X15

INPUTS, high impedance, gramo .5 meg., microphone .1 meg., radio .5 meg.

SENSITIVITY, gramo .25 volt, microphone .002 volt, radio .25 volt.

POWER OUTPUT, 15 watts.
Noise level—50db.

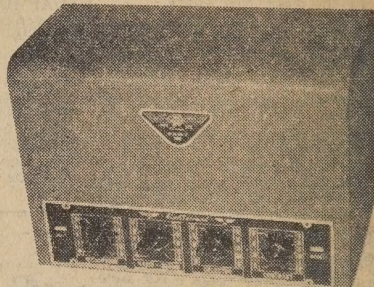
DISTORTION, maximum 5% at full output.

OPERATING VOLTAGE, AC 220, 240, 260 volts.

OUTPUT IMPEDANCE, 600, 300, 150, 75, 37.5, 18.75 ohms.

VALVES, 2/6AU6, 1/6SN7GT, 2/6V6GT, 1/5V4G.

DIMENSIONS, 13½" x 9½" x 8½".



Specifications, Model X30.

INPUTS, high impedance, gramo .5 meg., microphone .1 meg., radio .5 meg.

SENSITIVITY, gramo .25 volt, microphone .002 volt, radio .25 volt.

POWER OUTPUT 30 watts,
noise level—50db.

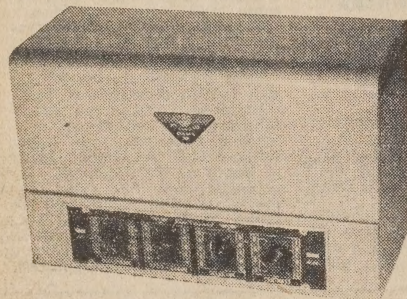
DISTORTION, maximum 5% at full output.

OPERATING VOLTAGE, AC 220, 240, 260 volts.

OUTPUT IMPEDANCE, 600, 300, 150, 75, 37.5, 18.75 ohms.

VALVES, 2/6AU6, 1/6SN7GT, 2/807, 1/5V4G.

DIMENSIONS, 16" x 10" x 8½".



Specifications—Model XV25.

INPUTS, high impedance, gramo, .5 meg., microphone .1 meg.

SENSITIVITY, gramo .25 volt, microphone .002 volt.

POWER OUTPUT, 25 watts.
noise level—46db.

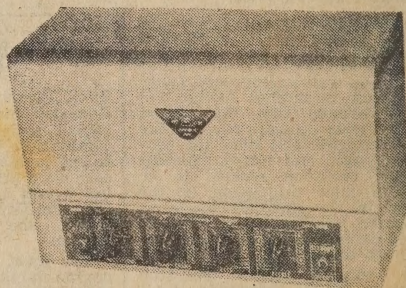
DISTORTION, maximum 5% at full output.

OPERATING VOLTAGE, battery 12 volts or AC 240 volts.

OUTPUT IMPEDANCE, 600, 300, 150, 75, 37.5, 18.75 ohms.

VALVES, 2/6AU6, 1/6SN7GT, 2/807, 2/6X5GT.

DIMENSIONS, 16" x 10" x 8½".



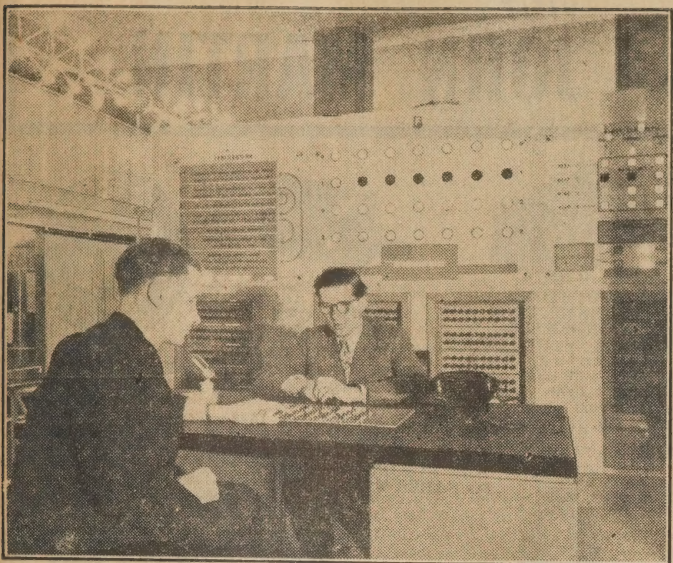
NOTE: This amplifier is designed for use from either battery or A.C. mains. Changeover for either operation is made by simply changing connecting cables supplied with amplifier.

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AND FROM ALL LEADING RADIO SUPPLY HOUSES.

FESTIVAL FEATURES ATOM STORY



The electronic computer "Nimrod," one of the exhibits at a Festival of Britain Exhibition at the Science Museum, South Kensington, London.

a spiral, and a beautiful periodic table of the elements giving the characteristics of each.

To illustrate the everydayness of science, and the fact that what happens in laboratories is not recondite, but of practical use, a motor-car battery is shown broken into parts, the parts further broken down into elements. Methods of so doing by electrolysis, separation and filtration are linked to this display, which leads, naturally, to the question of how atoms combine, what causes them to hold together?

ATOMIC BONDING

So we are shown the three main methods of atomic "bonding," the electronic, whereby the electrons around an atom attract others and so unite to form different compounds. The ionic, where the attraction is due to the inner charges of the atom, and the metallic "bonding," where the nuclei of the atoms are spaced in layers with the electrons diffused around the whole as a cloud, thus holding the mass together and giving metals their ability to conduct heat and electricity.

The atom and its fission are not overlooked, and novel animated displays show how as the result of work in Britain the atom was first "chipped," and then "split" by international team-work. As science is

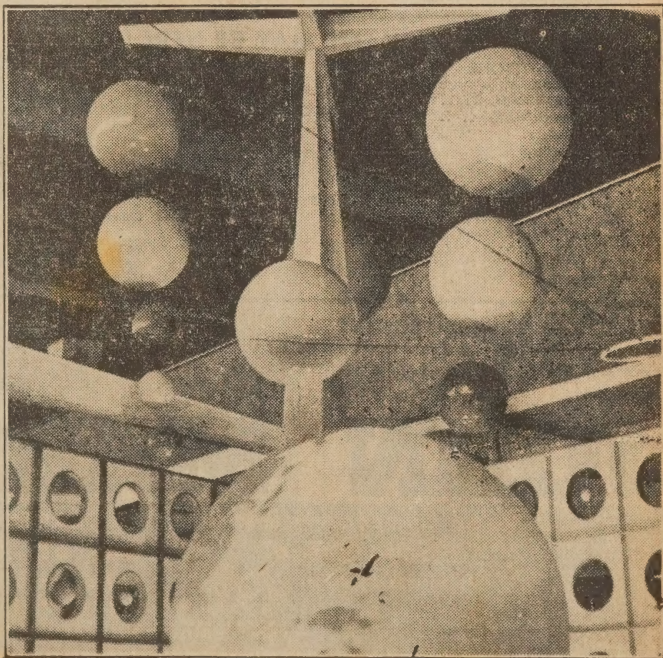
Science played a large part in the various Festival of Britain displays. In the Dome of Discovery at the South Bank Exhibition, Britain's achievement in science was illustrated by its practical applications in the modern world. How is matter—the substance of the world about us—built up into the many forms we know? Why does it behave as it does?

THIS whole theme was handled in such a compelling manner that it will undoubtedly set a new standard for displays of science. The technical jargon of scientists has been eschewed and information was presented in simple language and in a manner which can be easily appreciated. This was in the keynote of the exhibition—simplicity and stress upon the inter-locking and interdependence of the various branches of science.

THE ATOM AND ITS WORKINGS

What is an atom? The pace of the exhibition is set on entering through a series of rooms, each illustrating the graphite of an ordinary pencil at various stages of magnification, the final room showing an amazing construction of the graphite crystal enlarged ten thousand million times.

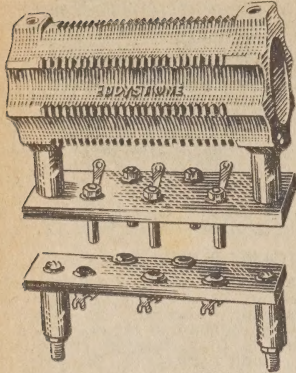
From this stage the theme is devoted to our knowledge of the atom and its workings, so there are sections devoted to the physical and chemical nature of matter. Here the elements are shown surmounted by



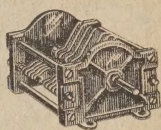
Scientific research during the past century was presented in simple language at the Festival of Britain Exhibition at the Science Museum, South Kensington, London. Above a model of the earth are a series of spheres made to the same scale, each representing in proportion the weight of elements in the earth's crust.



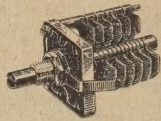
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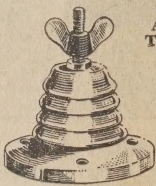
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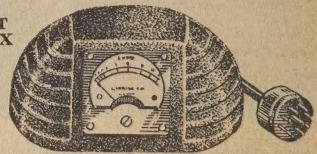


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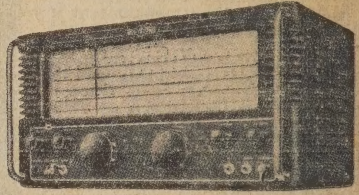
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international, no exhibition could deal exclusively with the work of one nation. Thus it comes about that the work of overseas scientists is also included.

BIOCHEMISTRY

From chemistry and physics, dealing with inorganic materials, the exhibition leads us to biochemistry, the study of the chemical processes of the body, and we see the mode of action of sulphadiazine, the use of the body and muscles make of chemicals and, to bring matters home, the actual laboratory apparatus used in the discovery by workers in laboratories in Britain, of the active fraction of liver which cures pernicious anaemia—the vitamin B12. Here is one of the thrills of scientific research.

As this work went through, American scientists found the same vitamin present in the fluid in which is grown the mould for making the antibiotic streptomycin, so that, instead of needing enormous supplies of liver for extraction, the vitamin is now procured from the streptomycin fluid.

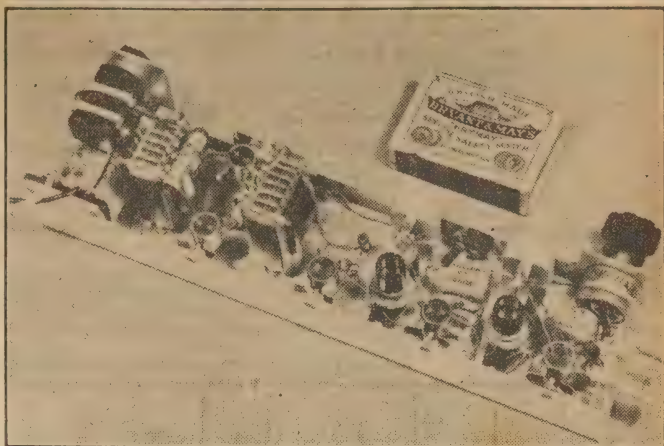
From biochemistry to the chemistry of the human cell, which is shown to have certain resemblances to that of plants. Just as the atoms of elements build up to form compounds and materials, so the cells of the body build up to form limbs and the various organs. The biological section of the exhibition shows this process in detail.

MECHANICAL BRAINS

Science is continually seeking the answer to the problems of nature. The brain, for example, contains thousands of millions of nerve cells. Here are shown mechanical tortoises, each with only two "nerve" cells which guide them to a light and, when their batteries run low, to a charging station.

Such models help in the study of brain mechanisms and, in this final section of the exhibition are modern

CRYSTAL RECEIVER OF TODAY



The biggest surprise at the £85,000,000 British radio and television show was the new radio set which works from dust taken from chimneys. The secret of the new radio—produced by the General Electric Company, is a "germanic crystal triode"—a development of the old crystal set—which operates with a loud speaker. This is the first time that a crystal set has been linked with an amplifier. The set was produced after secret experiments with dust from industrial chimneys. By purifying this dust, technicians have extracted germanium which is used for the production of the new valves used in the crystal set. The existence of this metallic element in chimney dust was first discovered by a German scientist, since when both American and British technicians have been racing to put it to use in wireless sets. The crystal valve used in the set is little bigger than a cigarette stub and it is expected to last from 50 to 100 times longer than the normal type or radio valve.

methods of scientific inquiry work now in progress. An electronic "brain" holds pride of place. It is actually a calculating machine which, by doing the work of months in minutes, materially assists the progress of science.

TELEVISION FINDS SUBMARINE

Behind the grim search for the lost submarine *Affray* is the story of Television serving in yet another vital role.

News of this revolutionary use of the Marconi Image Orthicon Camera was released recently by the Admiralty in London.

"It can now be stated," said their report, "that H.M. Submarine *Affray* which was lost in the English Channel was first identified by means of underwater television.

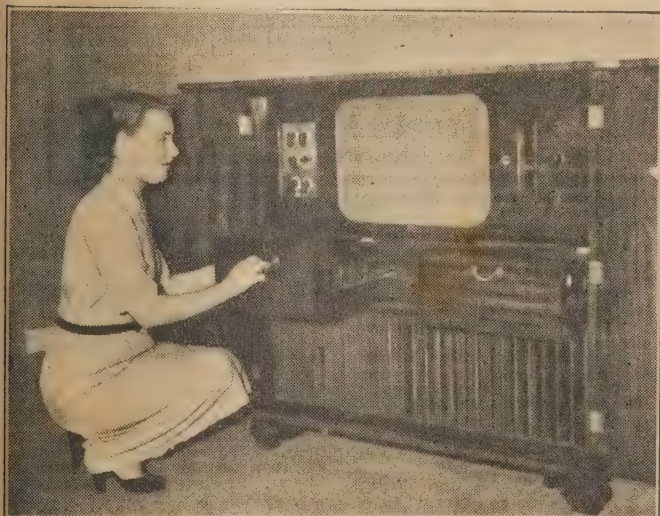
"Following the loss of the submarine a team of four members of the RN Scientific Service worked night and day for three weeks to produce the unit."

"Portable TV equipment, similar to that used for outside broadcasting, was obtained from Marconi's Wireless Telegraph Company whose prompt co-operation was greatly appreciated.

"The Naval scientists not only had to mount the camera in a specially welded water-tight container but also had to design and incorporate the various remote controls for operating the set.

"The container had to be set in a specially designed frame along with underwater lighting apparatus which had previously been designed to facilitate the work of under-water

"Early in June, viewers in the captain's cabin saw various parts of the *Affray* coming into view and the climax was when they read the name *Affray* on the screen.



Miss Thelma Butler, of Brixton Hill, takes a look at the Decca 'Knightsbridge' projection television and all-wave radio receiver and radiogram at the Radio Exhibition at Earls Court, London. With a television screen 18 by 13, and record players for both normal and long-playing discs, this set is the most expensive one at the Show. It costs £757/4/10 as illustrated, or in an antique oak finish £795/1/1.

FOR YOUR INFORMATION

The "Q Plus" range of Intermediate Frequency Transformers is of such proportions that it is felt that you, the consumer, should be advised of the characteristics of each type.

For some types the demand is small or are supplied to Government departments, manufacturers, etc., and if you particularly require that type it may have to be specially ordered by your distributor—others are stocked by all good distributors.

But first a little on the construction of these units. Experience has shown that the negative temperature coefficient ceramic condensers are by far the most reliable for I.F. transformer use and although their cost is higher we are always anxious to place quality above price. Secondly after long experimentation in humidity ovens we are of the opinion that our specially-selected polystyrene varnish is the most satisfactory for tropic and semi-tropic conditions. Each I.F. transformer is now subjected to an oscillographic test assuring that "Q" gain and bandwidth, etc., are well up to standards.

Although not yet released this is the first announcement of our revolutionary new non-softening base with silvered plated contact pins, replacing the conventional wire pins. For months we have investigated every type of solder tag and at last we feel that we have the tag which will speed up wiring and make dry joints a thing of the past.

"Q PLUS" I.F. TRANSFORMER SPECIFICATIONS

TYPE NO.	First or Second I.F.	I.F. Frequency	F.M. or A.M.	Winding "Q"	* Coupling	Construction	Tuning Capacity Used	Physical Size	Remarks
Q+ IF 1	First	455Kcs.	A.M.	120	.8Kc.	Spheroclad	110uufd	1 1/2 x 1 1/2 x 1 1/2	AC or Batt.
Q+ IF 2	Second	455Kcs.	A.M.	120	.9Kc.	Spheroclad	110uufd	1 1/2 x 1 1/2 x 1 1/2	AC or Batt.
Q+ IF 3	First	455Kcs.	A.M.	120	.8Kc.	Single pi	100uufd	1 1/2 diam. x 3	AC
Q+ IF 4	Second	455Kcs.	A.M.	120	.9Kc.	Single pi	100uufd	1 1/2 diam. x 3	AC
Q+ IF 8	First	455Kcs.	A.M.	145	.8Kc.	Spheroclad	100uufd	1 1/2 diam. x 3	AC or Batt.
Q+ IF 9	Second	455Kcs.	A.M.	145	.9Kc.	Spheroclad	100uufd	1 1/2 diam. x 3	AC or Batt.
Q+ IF 10	First	455Kcs.	A.M.	140	.85Kc.	Triple pi	80uufd	1 1/2 diam. x 3	Batt.
Q+ IF 11	Second	455Kcs.	A.M.	140	.95Kc.	Triple pi	80uufd	1 1/2 diam. x 3	Batt.
Q+ IF 12	First	1600Kcs	A.M.	90	.7Kc.	Triple pi Spheroclad	80uufd	1 1/2 x 1 1/2 x 1 1/2	AC or Batt.
Q+ IF 13	Second	1600Kcs	A.M.	90	.8Kc.	Triple pi Spheroclad	80uufd	1 1/2 x 1 1/2 x 1 1/2	AC or Batt.
Q+ IF 15	First	1900Kcs	A.M.	140	.4Kc.	Double pi	100uufd	1 1/2 diam. x 3	AC or Batt.
Q+ IF 16	Second	1900Kcs	A.M.	140	.5Kc.	Double pi	100uufd	1 1/2 diam. x 3	AC or Batt.
Q+ IF 17	First	4 M/cs.	F.M.	80	.8Kc.	Progressive	100uufd	1 1/2 x 3 x 1 1/2	AC
Q+ IF 18	Discrim.	4 M/cs.	F.M.	80	—	Progressive	100uufd	1 1/2 x 3 x 1 1/2	AC

* The coupling coefficient here allows for certain stray circuit capacities.

HINTS ON I.F. TRANSFORMER USE

When an I.F. transformer "looks" into a diode, the winding is shunted by the diode and its load resistor, this is usually about 1/2 meg ohm but has an effect equivalent to placing about 100,000 w across the secondary of the I.F. transformer. This will drop the "Q" factor of the winding and if arrangements were not made to make up for this the co-efficient of coupling would be greatly decreased. I.F. transformers made by "Q Plus" overcome this difficulty by decreasing the physical distance between the two windings, thus if a No. 2 I.F. is used where a No. 1 should be—

over-coupling may result and if a No. 1 is used where a No. 2 should be—under-coupling will result. Therefore always be sure you receive the correct I.F. types.

Should you be desirous of using two I.F. stages, then appropriately you should choose two first and one second I.F.

"Q Plus" I.F.'s come already aligned but should this, for some reason be upset, always align to the peaks where the core is in its outermost position: it is sometimes possible to obtain an inner peak but this will alter the correct coupling coefficient.

Always align I.F.'s through a

valve never straight on to the I.F. itself as the loading created by the oscillator will make peaking impossible.

RECOMMENDED TYPES

AC midget, Battery Personal Portables, &c., or other sets where size must be kept small, including car radios

I.F. 1 & 2. General Purpose, High Gain, A.C. Equipment

I.F. 8 & 9. General Purpose, Low Gain, A.C. Equipment

I.F. 3 & 4. High Gain Portables where space is available and battery or vibration sets for country operation

I.F. 10 & 11

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COMMENTS ON POPULAR SCIENCE

It is lucky that stability is almost non-existent. Nothing is permanent; even our finest buildings will be mud and dust in due course. Everything changes. It is the principle of life you see in the forms which renew your own body.

A DROP of water in a rainstorm cannot exceed a certain size without breaking up and this is lucky for you. Tiny drops have pressures of 20lb per square inch and more inside their controlled surface, but at a certain diameter they fall to pieces because the localised grip has been exceeded by the total strain.

The water assumes a globular form because it balances out the internal force and this is a condition which we see relatively reproduced in the atom bomb where certain isotopes such as that of uranium become mildly unstable. Their solar system has its own Milky Way, and bombardment is allowed to reach the inner nucleus.

CRITICAL SIZE

From this you will guess that, above a certain size, a bomb might be too easy to set off, and below the size of a kilogram or so the bomb becomes so stable that nothing much can be done with it.

I am told that ancient mariners lick their finger, hold it up in the air and say, "Nor, nor" by east, abaft the binnacle, or words to that effect. In short, they feel which side of the finger grows cold and know that it is facing the point from which the wind comes.

This is the principle of nearly every refrigerator. Even savages used to put their water, or "twala twala," as the boys' books used to call native beer, in a porous vessel. As the water, better still the beer, evaporated, the liquid gave up its heat, and the resulting cold provided the necessary chilled refreshment.

To this day it always pleased me to see someone light a gas-jet under a refrigerator burner and to know that heat is producing cold. Cold is merely the absence of heat, and these machines work by a series of evaporations and condensations in a continuous cycle.

Some liquid, such as sulphur dioxide, under pressure, is caused to evaporate, and in doing so cold is produced. The gas is then condensed again by pressure, when it becomes liquid once more to go through its cooling evaporation. In so doing, it cools the rest of the machine.

MAKING SNOW

If carbon dioxide is used in liquid form and allowed to evaporate quickly into gas, the cooling is so quick that solid particles of carbon dioxide "snow" are formed. You will realise that whether the evaporation is caused by a sudden lowering of the pressure or by the application of heat to the liquid does not make much difference.

The working fluid, for that is all it is, merely serves as a method of transferring heat; whether you use carbon dioxide, sulphur dioxide or ammonia solution is a matter for design and economics.

In the same way, as I think I once explained, water is used in a boiler to be turned into steam and the steam merely acts as a vehicle for heat in order that, in its anxiety to expand, it may produce power.

Other liquids are equally effective. Air is rather difficult to heat, but mercury makes a splendid carrier and is only inclined to failure by its cost, and some danger to those who may use it without precautions.

When you see vacuum pumps at work in a steam engine you will know that the engineers want to condense the steam as soon as it leaves the engine, not only so that the water can be used again for warming the boiler, but so that the waste steam can get away from the engine quickly without having to be pushed out.

In the old days they used to squirt water into the engine cylinder, but they soon found that if the cylinder was cooled in this way, the entering steam from the boiler wasted its energy by merely warming the metal of the engine.

WHAT IS LIGHT?

When writing about light I think I did not make it clear that what you and I call light is only one form of an ethereal oscillation. It mildly resembles wireless waves except that its frequency is vastly higher.

Grey light from the sky is a combination of all the spectrum colors, and if you paint a white disc about 3in diameter with segments of each of these rainbow colors and then spin like a top you will soon find that the colors blend into white.

There are many other kinds of light, each different from its neighbor. There is the cathode ray which makes some of the platinum compounds fluoresce, a property very useful to makers of television screens.

X-rays are also light, but have quite different properties. They are

trum colors, you would never have taken white to be plain and not colored.

If the sun's rays had been green, your relative eye sensibility would have been different, for you are a creature of evolution in nature's plan. You would have looked at a pair of bright red pants and remarked, "What a pity they are not colored." White would no doubt seem most glaring and out of place.

Heat is merely a slightly different form of light with a longer wavelength. It can be focused, as in the normal electric fire, and its rays can be bent like those of light by using the proper material.

In the early days of infra-red photography, when it was first discovered that photographs could be taken through cloud, the first experiments were made with lenses constructed of rock salt because this substance did not cut out the heat ray.

There is no real difficulty in taking a photograph inside a dark room by the light of a kettle of hot water.

At the other end of the stick we have ultra-violet light which is invisible, and which does not pass through lenses containing lead. That is why special glass has to be employed if the full benefit of the sun's rays is to come into your house.

In this world we know very little about light, but we do know that it is a somewhat material thing, and I think that when atomic power has been further investigated, and we have found how to change matter into energy quite easily, we shall be able to write knowledgeably about the weight of light. For light has weight and actually hits us all the time.

WEIGHT OF LIGHT

It has been calculated that if a cent was raised to the temperature of the inside of the sun, the actual weight of light proceeding from it would knock down everyone within a radius of over five miles.

But there's still plenty of interest in commonplace things. How exactly does a tree draw up its moisture to a height far greater than the usual 30ft? And if each section is isolated by a form of valve, these valves must be operated "knowingly" or we could design a similar species of perpetual motion machine.

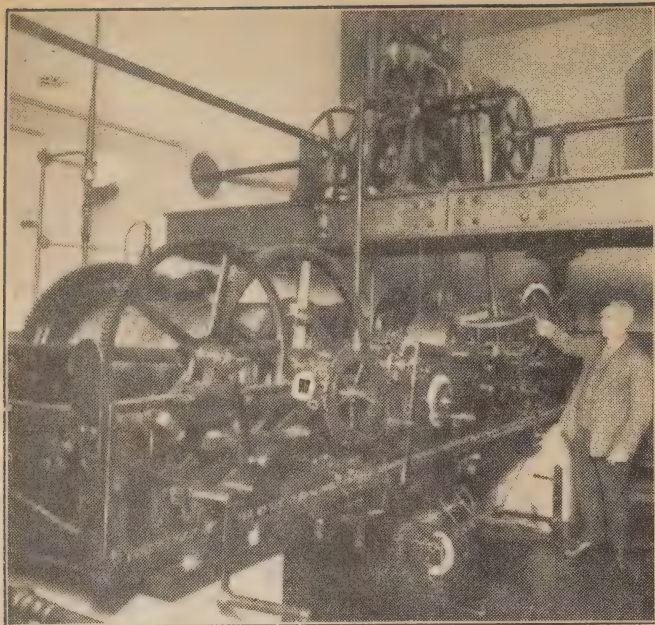
And here's something else: Cars, in my opinion, do not run better at night. It is the result of apparently reduced distances owing to the lack of far-sighted vision. Nor do I attach much importance to the moisture in the air theory, because if moisture is to be introduced to an internal combustion engine it should, I imagine, be put in as liquid against the hot metal.

We want it not to reduce the temperature of the burning gases, but to absorb heat which would otherwise be wasted by passing into the radiator through the jackets.

by Professor
A. M. Low

capable of penetrating opaque substances owing to their very short wavelength with which the particles of normally solid matter are liable to interfere.

If you had eyes which were sensitive to X-rays you would be able to see through walls. If you had eyes like a microscope you would see the air full of living creatures, and if it did not happen that the sun's rays were composed mainly of these spec-



The "works" of Big Ben are on rather a larger scale than those of your watch! They are wound each day by means of the handle at the left—a job that takes about one hour.

one of them has to do with time. So many hours a week for so much.

Think how the time factor has entered our homes and especially into the kitchen. There is no need for a cook these days. All we need is a mixer-upper of the necessary ingredients, a stove with a thermostat, a clock and a thermometer.

To the housewife I say that you day as a good cook is done. No longer can you boast to your husband that the pie is as good as his mother used to make. You cannot avoid making it that way or even better, if you follow the instructions.

AUTOMATIC COOK

The ordinary processes of your kitchen, no matter how poorly equipped it may be in other ways, are reduced to a mere matter of mixing the food, bringing the oven to the required temperature as measured by a thermometer, get the thermostat and then buzz off down the town or into next door for a powder wow with the neighbor.

The heat of the oven is shut off automatically after the required time. Even if you forget to come home the dinner will still be in the oven cooked to a turn for hubby when he gets in from work (after 6 o'clock).

Yes everything is done by time.

TIME WON'T WAIT FOR YOU

In a civilised world, Time is an important and indispensable factor. But, in the world of today, with its mad search for speed, there does not appear to be enough Time to accomplish all that we wish.

MAN'S conception of time is largely based on his immediate occupation and amusements. That, of course, is when he thinks about time at all for, in the main, he is not really aware of it. It is taken for granted.

We live our life in the stream of time and hardly ever think of it except in relation to the present and the future. Of course, we look at the clock now and again and especially knock-off time.

Many of us could define time in various ways. For instance it is what the man sings out at six o'clock in NSW, "Time, gentlemen, please." To be sure, there is never enough of it when we are being amused and too much of it when we have work to do.

We speak of "saving" time and "wasting" time. Regarding the former I have never found out what a person does with the time he saves except waste it in some other direction.

Sometimes we say that we have "no time." These are the occasions when perhaps you are approached by someone for a favor. "I'm sorry," you

say, "I have no time at the moment. I have an urgent appointment in five minutes." You thereupon go off to afternoon tea!

We cannot get away from the time factor what ever we do.

In business, time largely governs whether we make a profit or lose money. The time involved in a manufacturing process is after the major cost to be reckoned with. A workman is paid by the hour. He can only do a certain job in that hour.

There are many who say that the present-day workmen should do more than he actually does in an hour. The workman retorts that the boss should do likewise — and so it goes on. Endless worry, strikes, arbitration courts, awards and so forth. Every

So many minutes for this. So many hours for that and there you are.

It is no use saying you have no that kind of stove. They are available. Get one before the sales tax goes up again.

Then again there is the sporting field. Everything is done by the split second. Stopwatches time the horse races and all other kind of races including the human races.

TIME WON'T WAIT

Timetables of transport facilities are timed to the second. They have to be for, if we arrive early at work what do we get? Nothing. But if we arrive late what do we get. Either our pay docked or the sack. At work we are timed on "bundys." It is most difficult nowadays to get someone else to punch the "bundy" for you.

Then of course there is the law. In this function "getting time" is a well-known phenomenon.

There is a time for bed (thank goodness) and a time to get up (curses), a time for work (ah-h-h) and time for a drink (hooray)

by Calvin
Walters

Our split-second timing can be very annoying. For instance, when we are running for a train and miss the thing, it's annoying to find that it ran to schedule, right on the second. On the other hand, when we're on the train and have to catch a connection, we hope the one we are in runs a bit early. We are never satisfied.

On for the good old days a few centuries back. Man didn't bother much about the time then. He had nowhere to go anyway, unless he walked or rode a horse.

When travel and commerce became important, man became a little more time conscious but previous to that man lived in his own community and his clock was the sun. It rose in the morning and set at night and there he was. During the intervening period he did a certain task, fought a duel or two, spent a while at the "local" and then went to bed.

TIME IN FEET

That the sun appeared and disappeared at fairly regular intervals primitive man was not slow to note. He noted that it would pass a certain fixed object such as a tree at about a certain time each day.

He could, by this means if he wanted to, determine roughly a certain time or place in the day. He could stand in a certain position with reference to a post or a tree and say if the time was the same as the day before.

Later on he discovered that although the rising and setting of the sun varied with the seasons a shadow cast by the sun was fairly constant.

He thus began to use a fixed pole for a shadow caster and measured the length of the shadow. He found that, if he measured the shadow today, it would be about the same length at the same time tomorrow.

Strangely enough man at this time measured the shadow with his feet so that the anomaly arose whereby, upon asking the time, the answer was given in feet. This would be about as confusing as stating that the length of the local cricket pitch was four o'clock.

This shadow casting was the forerunner of the sundial. This primitive instrument was the principal means of telling the time from about 1500 to 1000 BC (NOT Before Clocks), right up to about the 16th century. In fact, sundials were used up to the 18th century in England and the 19th century in some parts of Europe.

EARLY METHODS

Only the wealthy could use clocks which, in the latter part of the 18th century cost as much as £5 to £10 in England. This was a vast amount of money in those days.

Certain mechanical means were used to tell the time as long ago as 1000 years BC. These took the form mostly of floats in tubes of water from which the water was allowed to drip slowly from a fine orifice. As the water fell the float also fell and either worked a hand revolving around a calibrated dial or a pointer attached to the float which marked the time on a graduated stick.

Alfred the Great was supposed to have used a notched candle which told the time at the highest notch when the candle was burning down.

During the beginning of the 14th century the Italians made what are

reputed to be the first mechanical clocks which bear any similarity to the clocks we use today.

Then in 1362 a German by the name of Henry de Vick made a clock for Charles V of France. It is there today, somewhat modified, in the tower of the Palais de Justice in Paris.

Even in those days strict accuracy did not matter a great deal and for a clock to be a quarter of an hour fast was of no consequence.

It was not until sea travel became popular that accuracy was demanded. In 1598 Philip III of Spain offered a reward for a means of finding a ship's longitude at sea. Then Holland offered a reward, but it was not until 1670 that Charles II of England learned that a means had been found of determining the longitude by means of the stars. This led to the establishment of the Greenwich Observatory.

Even with a means of determining the longitude by the stars it is essential to have an accurate time piece to use in conjunction.

In 1714 the British Government offered a reward for just such a "chronometer" as it is called. In 1764 a successful test was made of a chronometer invented by a John Harrison. Improvements were made to this by John Arnold in 1782.

Up to the present time, great progress has been made in the accuracy of time keeping so that it is possible to obtain an accuracy to within one

thousandth part of one second.

This has been achieved by means of the quartz crystal clock. Up to the advent of this clock the earth was the most accurate timekeeper available for the purpose.

In the obtaining of accurate time a transit instrument is used. This is best described as follows. Every place on the globe has its situation described in terms of meridian of longitude, and parallel of latitude.

For the purpose of time taking only the meridian of longitude is used. At the situation of the observatory a domed-roofed structure is built with a slot in the roof corresponding to the meridian of longitude.

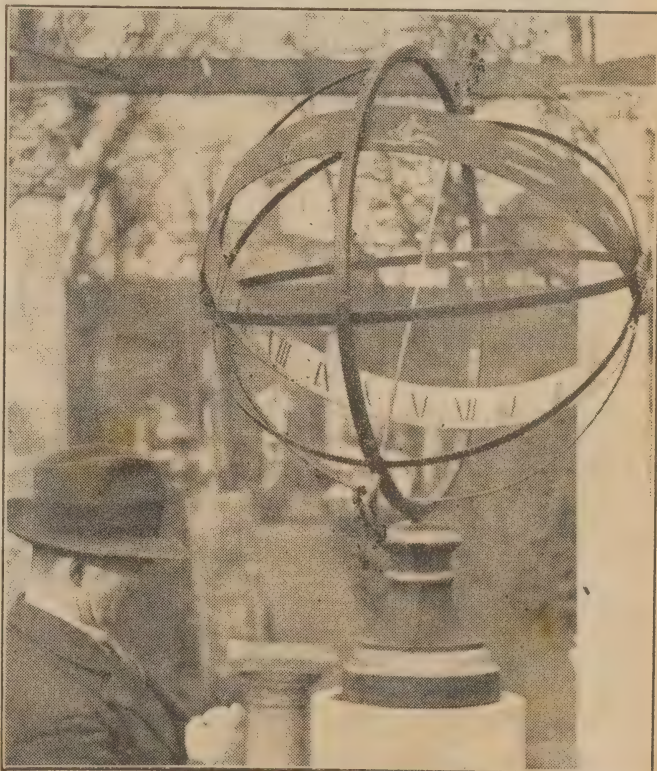
STAR TIME

The movements of certain fixed stars are known in advance. In fact catalogues of these stars are printed and their movements predicted years ahead. Their positions in the heavens are known, and calculation gives the time when a certain star will cross the meridian.

Inside the building is located the transit instrument—a form of telescope and at the appointed time an observer takes up his position and waits for the particular star to make its appearance.

When this happens the observer focuses a fine hair fixed to the interior of the telescope, to appear to cross the centre of the star. As this wire is moved along, several electric

(Continued on Page 95)



A contrast is provided by this old Dutch sundial which has marked off the hours for generations.

Here's the smart easy way to **CONVERT TO L.P. MICROGROOVE**



It's so simple to convert a single-speed radiogram or normal radio to play the new, popular L.P. records with the Goldring 3 speed player. As well as L.P., it plays the normal "78" records. And in both cases the reproduction is perfect.

**WITH THE
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 B.S.R. 3 SPEED MOTOR**

*Complete with auto-stop
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The features of this Goldring 3 Speed Record Player are—

Attractive carrying case, finished in finest quality leatherette.

The superior unit is built by Birmingham Sound Reproducers, and used by leading radio manufacturers all over the world.

Lightweight pick-up with high fidelity magnetic head. Weight at needle-point is adjustable. Two permanent sapphire styli supplied—yellow for microgroove, blue for 78 recordings. Changeover is readily effected.

Change speed by external knob marked for 33 1/3, 45, 78 rpm and employing the Rotocam method—simple and absolutely reliable.

Stops automatically—positive and smooth action, operates on all types of records. Completely concealed below deck-plate.

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The BSR 3-Speed Motor Model GU4



The Goldring L.P. Record-Players feature exclusively the G.U.4 motor. Beautifully styled modern appearance, and faultlessly smooth operation make the G.U.4 the long-playing enthusiast's only choice. The famous B.S.R. deluxe motor is the 4-pole induction type 200-250 volt (with immediate change to 100-125 volts). Rim drive to heavy pressed steel turntable, recessed into deck-plate. Rubber mat, anti-static and non slip, supplied with each turntable. Low rumble and vibration factor . . . no belts to cause "wow."

PRICE £15/15/- (including 33 1-3 % sales tax)
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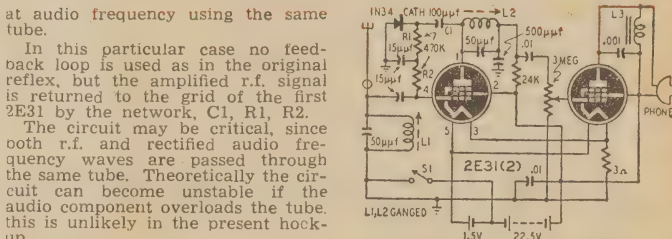


An open wooden box, likely a tool kit or a storage container for a specific craft. The box is divided into compartments. The left compartment contains a bundle of twine or rope, a small wooden peg, and a small metal ring. The right compartment contains several small, rectangular objects, possibly pieces of wood or bone, arranged in a row. The box is shown from a top-down perspective, with the lid open. The background is a plain, light-colored surface.

The signal is picked up on the collapsible antenna which extends to 18 inches. A switch on the antenna turns on the set when the antenna is extended. The incoming r.f. signal passes through the first 2E31 tuned by L1 and L2.

A black and white photograph showing a hand holding a vintage mobile phone. The phone is a large, rectangular device with a prominent circular speaker or microphone on the front. A long, thin antenna extends from the top of the phone. The hand is positioned to hold the phone from the side, with fingers visible gripping the device. The background is a plain, light-colored surface.

The reflex type circuit is one in which the vacuum tubes perform double duties as both radio-frequency and audio-frequency amplifiers. The incoming r.f. signal is amplified at radio frequency (thus giving a stage of r.f.), rectified by a detector, (in this case the 1N60 (1N34 can be used), and then amplified at

SI ASSOCIATED WITH TELESCOPE TYPE ANT AT POINT ϕ

The simple Privat-Ear reflex circuit.

Current drain is very low, since the subminiature pentodes draw a total of 100 ma filament current and 0.8 ma plate current. Two 1.5-volt cells and a 22.5-volt hearing-aid battery are used.

—RADIO ELECTRONICS

Fluorescence, as it is generally known, is often an indication of a good vacuum rather than a bad one, and has no effect on the operation of the valve.

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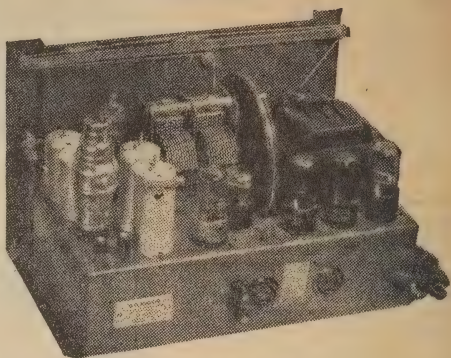
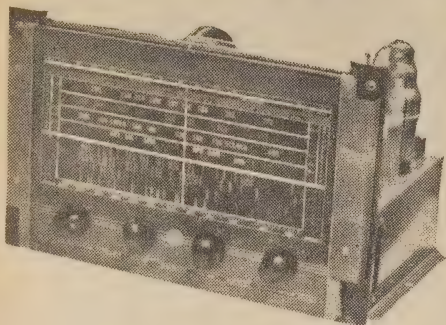
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WITH MATCHED DUAL SPEAKERS

£35/15/-

FREIGHT
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COMPARE THESE FEATURES

Ultra modern circuit with permatured iron cored coils and intermediates giving good interstate reception and a short wave range of 12,000 miles.

High gain audio with push-pull output and tone control gives you high fidelity reproduction from both radio and your favorite recordings.

Power switch is fitted to the tone control of all chassis thus enabling the power to be completely switched off from the set. Radiogram switch combined with wave change switch.

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- Speakers supplied are Magnavox 12" and 8" permanent magnet with tropic proof transformer. Single 12" supplied with 6 valve chassis.
- Large calibrated edge lit dial in plate glass (11" x 7") with main stations in each State in prominent type, fitted with counterweight drive and supplied with polished escutcheon. Indicator lights on dial showing which band in operation.

6 VALVE WORLD-RANGE CHASSIS

£29/10/-

SPECIFICATIONS AS EIGHT VALVE UNIT, BUT WITH SINGLE 6V6GT OUTPUT VALVE AND SINGLE 12" SPEAKER.

FREIGHT EXTRA

RECORD-CHANGERS AND PLAYERS

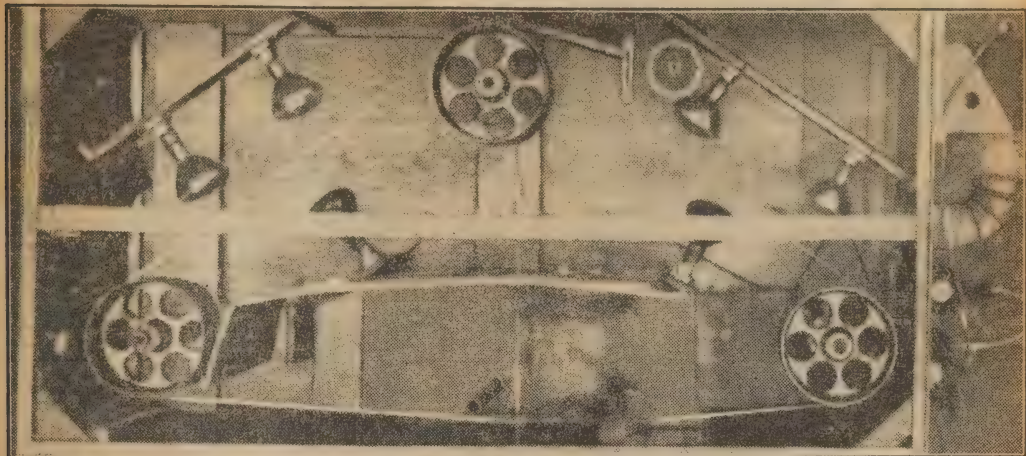
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CLASSIC RADIO

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A HIGH TEMPERATURE ADHESIVE TAPE RESISTOR



The resistive coating used in the NBS high-temperature adhesive tape resistor is applied in this cabinet. A spray gun deposits the formulation on to an endless belt of asbestos paper tape. Infra-red lamps accelerate evaporation of the solvent.

Printed electronic circuits—in which components and wiring are superimposed directly on insulating bases—are being used increasingly because of their adaptability to economical mass production and because they facilitate miniaturisation of equipment. A major disadvantage of the printed circuit method, however, has been the difficulty of incorporating satisfactory resistors in the circuit.

THIS difficulty has been largely overcome by an adhesive tape resistor method recently devised by B. L. Davis and associates of the National Bureau of Standards (US). The new resistor method was developed as part of a program of electronics research and development sponsored by the Navy Bureau of Aeronautics.

In this technique, circuits are first printed in narrow metallic bands on insulating bases, leaving a small gap at each point where a resistance is required; one of the self-adhesive resistors is then cut from a strip and pressed into position. Much better control of resistance values is possible than with previous printed resistor methods, and higher yields of acceptable assemblies are assured.

The new method thus appears to combine the advantages of printed resistors and of separately manufactured resistors.

The NBS tape resistor was developed to withstand the high temperatures of very compact equipment and operates satisfactorily at temperatures up to 200deg. C; in other electrical characteristics it is similar to present film-type carbon resistors.

FIRST METHODS

In the past, the usual method of introducing resistances into printed circuits has been to paint or spray a strip of resistance material directly on the base plate. The desired value of resistance is obtained by varying the composition and dimensions of the resistance strip laid down.

Production of individual resistors to close tolerances by this direct-coating method is difficult, and the reduced probability of producing a number of satisfactory resistors on

the same base plate greatly decreases the yield of acceptance assemblies.

Compositions and techniques used in making and applying the new tape resistors are remarkable for their simplicity. The resistor consists of a mixture of graphite or carbon black, resin, and solvent, applied in a thin layer to a thin roll of asbestos paper tape.

The resistive coating is sufficiently adhesive to stick to an insulating base plate and to make satisfactory electrical contact with metallic terminals. When the resistor is in position, the resistance film is protected from abrasion and electrical shorts by its asbestos-tape backing.

Resistor dimensions are kept constant; a variety of coating formulations give a range of values from about 100 ohms to 10 megohms.

SPRAYED MIXTURE

The resistor is manufactured by spraying the resistance mixture on to a moving belt of tape. A thin (0.002 inch) protective film of polyethylene is lightly pressed over the resistance coating for protection in handling and storage; it is easily removed when the resistor is used.

An electrically driven slitting machine quickly cuts the tapes into long strips of the desired width.

At present, the resistor tape, cut to width, is applied to printed circuitry by hand from a continuous spool; the tape is pressed into position and cut off with a razor blade. Plans call, however, for development of a device comparable to a wire stapler that will accept a roll of the resistor tape and apply and cut off a resistor of standard length each time a knob or handle is pressed.

Silicone resin is used for the binder-adhesive because of its suitability for high-temperature operation. Since the curing temperature of the silicone-resin formulations is high (300 deg C), and since curing is done after the resistors have been positioned in the circuit, the NBS tape resistor is at present applicable only to glass or ceramic base materials.

GRAPHITES USED

However, enough work has been done with lower-curing resins to indicate definitely that they can be used in making tape resistors having cure temperatures low enough for application to some heat-resisting plastic materials. These resistors would be suitable for conventional operating temperatures.

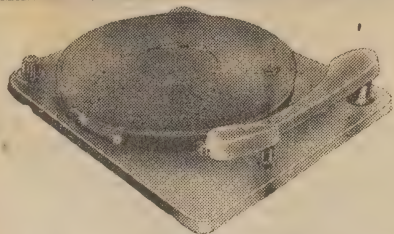
The possibility of varying resistor dimensions to obtain a range of values was considered but rejected. This so-called "aspect ratio" system has the advantage of reducing the number of formulations needed for a complete resistor range, but it complicates equipment design and production.

Resistor dimensions were therefore standardised at a length of 0.5 inch (0.3 inch interelectrode distance) and a width of 0.13 inch plus-minus 0.02 inch; this slight leeway in width permits some adjustment of resistor value in the slitting operation. With constant dimensions, wattage ratings are substantially independent of resistance value, and different contact resistance values due to different contact areas of silver and resistor are eliminated.

Both natural and synthetic graphites, as well as various carbon

The **WARBURTON FRANKI** Page

Featuring the latest Radiogram equipment for both MICRO - GROOVE and Standard Recordings



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- Easy speed change 33 1-3, 45, 78 R.P.M.
- Automatic stop.
- High fidelity pickup with 2 sapphires.
- Rubber mat on turntable.

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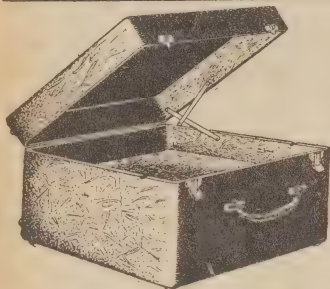
B.S.R. MU14 3-SPEED MOTOR AND TURNTABLE

Features easy knob change of speed.

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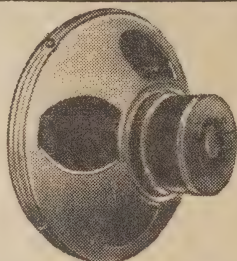


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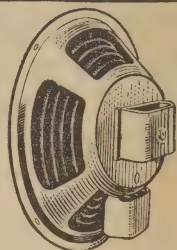
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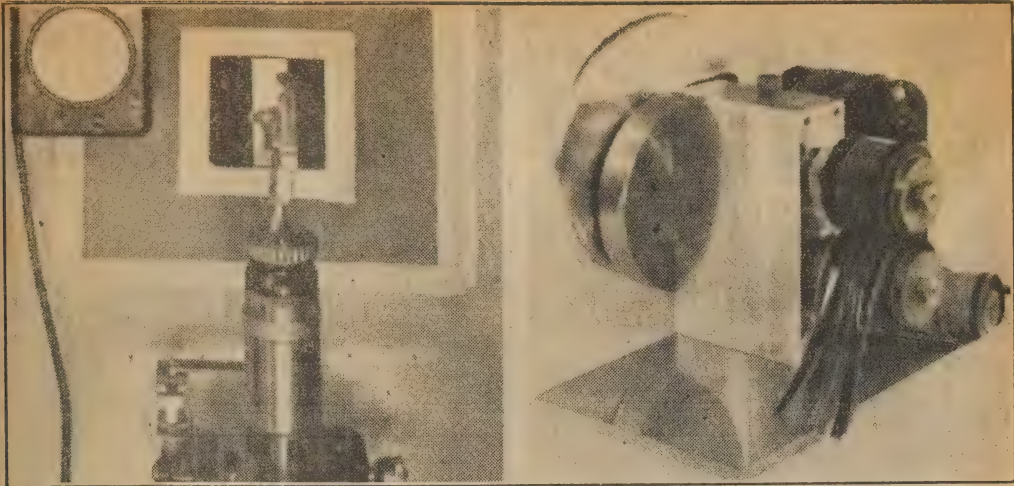
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End view of the cabinet (left) showing spray gun. A specially designed instrument (right) splits the resistor tape into desired widths. Twelve disc knives mounted in pairs and spaced by accurately ground spacers overlap slightly to give scissors action.

blacks, are used in the resistor formulations. Values of resistors are varied by changing the ratio of carbon to resin in the mixture and by using different carbons.

The proportion of carbon to resin ranges from 10 to 50pc; leaner mixtures have been found to give less favorable characteristics.

Tape resistors made from graphite mixtures have proved remarkably stable at ambient temperatures of 200 deg C. Another advantage of graphite formulations is that unusually low resistance values—down to about 100 ohms—can be obtained.

Unfortunately, however, the useful upper limit of the graphite formulations seems to be about 5000 ohms. Carbon blacks, which are less desirable at high temperatures, give values from 5000 ohms to 10 meg-ohms. Only a few carbon blacks have been found that yield tape resistors satisfactory for operation at 200 deg C. For most resistance ranges however, carbon-black tapes have been made that are satisfactory at 170 deg C.

BALL MILL

The coating formulation—carbon, resin, and solvent—is agitated with porcelain balls on a ball mill for at least 72 hours before it is sprayed on the tape. Spraying is done in a special cabinet. To secure a uniform coating, the tape, in the form of an endless belt 13ft long and 1½ in wide, is moved rapidly past a spray gun many times as the spray mixture is slowly deposited. A number of infra-red heat lamps, mounted within a few inches of the moving tape, hasten removal of solvent during spraying and dry the tape to the desired degree of stickiness after spraying is stopped.

The tape-slicing machine employs 12 disk knives mounted in pairs, slightly overlapping so as to give a scissors action and separated by accurately ground spacers. A small sample of the tape may be tested for value before the entire tape is slit. Testing is done by cutting the sample into a series of strips varying in width by 0.01 inch over the range 0.11 to 0.15 inch and making up a test plate from these strips.

On the basis of the test results, the slitter can be set to cut the entire roll into strips of the width necessary to give the desired final resistance value. A single belt of resistance tape yields approximately 1500 resistors.

Proper care of resistors after application to the printed circuit is extremely important. The curing process hardens the resistor, bonds it more firmly to the plate, and stabilizes its electrical characteristics.

Although the optimum cure for different formulations differs considerably, a compromise cure of 4 hours at 300 degrees C has proved satisfactory, and has been adopted as standard. Curing is done in a temperature-controlled electric furnace to which an aluminium liner has been added to secure more uniform temperature distribution.

In using the resistors at 200 degrees C, it has been found that those made from some formulations change more

sharply in value during the first 24 hours, then remain more stable for several hundred hours. For this reason there is some advantage in following the standard 4-hour cure at 300 degrees C.

As changes in the resin in the resistor film take place quite slowly at room temperature, the resistor tape may be stored for long periods. Its storage life may be further extended by refrigeration.

Testing and development of tape resistors are continuing at NBS. This work utilizes a test oven of special pattern design that permits automatic recorded measurements to be made simultaneously on a large number of resistors without removal from the oven.

Improved resistance formulations are being sought, particularly for certain ranges. Attempts are also being made to develop a satisfactory additional protective coating for application to the positioned resistor.

TILT ADDS TO UHF SIGNAL RANGE

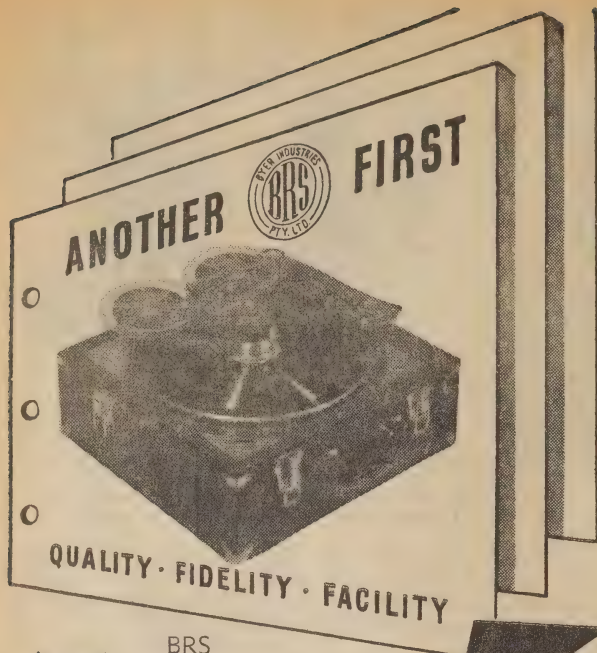
TELEVISION signals in the program service area of an ultra-high-frequency station can be doubled in strength by a slight tilting of the transmitting antenna, Dr. C. B. Jolliffe, executive vice-president in charge of RCA Laboratories Division, has revealed. The tests were conducted at Bridgeport, Conn., using the facilities of RCA-NBC's experimental station KC2XAK, which has been in regular operation since 1949.

The antenna built for the tests was erected on one side of the Bridgeport transmitting tower. By means of a motor-driven arrangement, the antenna was rocked back and forth in an arc of approximately 12 degrees to permit engineers to record the resulting variations in signal strength. Field tests were made at several locations in the primary service area of KC2XAK and also at Princeton, NJ, 90 miles away. Results in every instance showed that the received signal was at its maxi-

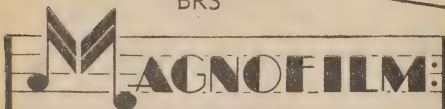
mum when the antenna was tilted approximately 2.5 degrees up or down.

This gain in signal strength, achieved without increasing the power of the transmitter, Dr. Jolliffe pointed out, would be particularly valuable in the present state of development of the UHF art. Unlike the very-high-frequency stations now providing program service to the public, UHF stations are limited in their power by the types of electron tubes available for transmitters.

By making use of the additional signal strength which the tilted antenna delivers, the effect on the quality of the television picture would correspond to that which would be produced if the power of the transmitter were to be multiplied several times. Furthermore, he added, this gain would bring about a noticeable improvement in picture quality on UHF television receivers installed in the outer, or "fringe" areas of program service.



BRS



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A 'FOOLPROOF' TURNTABLE DRIVEN TAPE RECORDER

For a considerable period the brand of "BRS" has been associated with high quality disc recording and reproduction.

- Constant and extensive development has proceeded on methods of obtaining still greater realism in recorded sound. The "BRS" Magnofilm Tape Deck now proudly presents itself as a precision instrument for high fidelity magnetic recording on plastic tape.
- Your "BRS" turntable, with heavy flywheel action, will provide "wow-free" power for the unique tape-driven capstan to produce high quality recordings with this exciting new product.
- With oscillator unit, pre-amplifier and equalising network available in a convenient sub-chassis, your present amplifier or high grade radio receiver becomes a high fidelity tape recorder and reproducer.
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Two tape speeds— $7\frac{1}{2}$ " per sec. at 78 r.p.m.
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Loads 600' tape on standard 5" reels.

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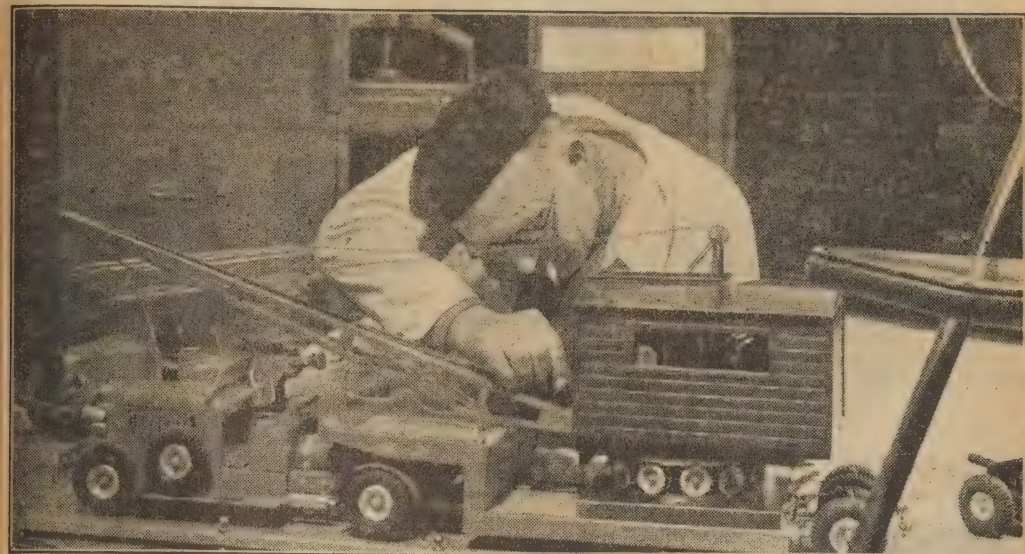
Low cost, together with facilities for connection to existing amplifiers or high grade radio receivers.



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MODEL HELICOPTER REALLY FLIES



Mr. Child's own son Neil, now 18, is well beyond the age of enthusing over his father's new ideas, but Mr. Childs has been turning out such model for many years as a hobby. This crane he is adjusting has all the elaborate controls and gear-reductions which work like the real thing.

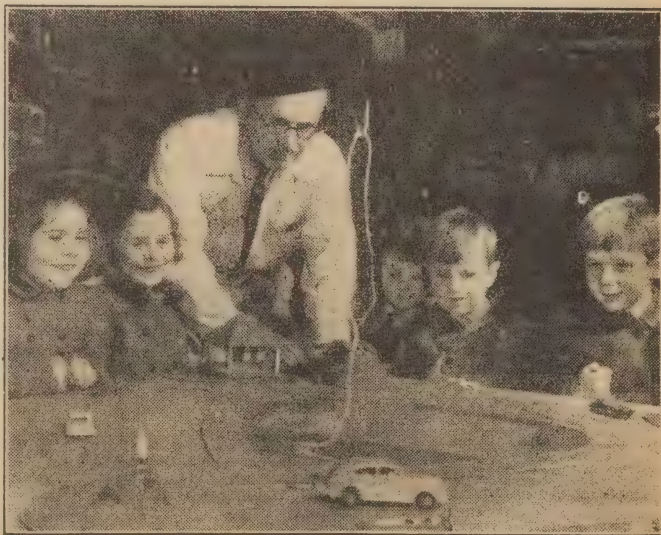
If Mr. Andrew Childs were Father Christmas' right-hand man there would be plenty of breath-taking toys in Christmas stockings every year. As it is his novel toy inventions have attracted widespread popularity and his scope is limited only by what are commercial propositions for he is the "ideas man" behind a small Warwickshire toy factory, exporting far afield.

THE latest ingenious device from his fertile brain, which has already produced a big family of cars, aeroplanes, ships and other novelties, is a remote-controlled helicopter which can be made to take-off and land on a sixpence. Its finger-tip controls provide a fascinating lesson in aerobatics, making it much more than a plaything.

This 45-year-old Warwickshire engineer decided after the war that there was scope in the toy industry for new ideas, and so he turned his hobby into a living, aided on the production side by his partner, Mr. L. Travers-Smith, a fellow-engineer and electrical expert.

A few months before each Christmas Mr. Childs will think up a new idea for his next toy and, sure enough, by Christmas-time the latest invention is thrilling thousands of youngsters in the toyshops. "I just knocked it up," is his way of describing how he gets his ideas. He designs no elaborate blueprints for his first working model; that comes later when Mr. Travers-Smith takes over the production.

The idea for the model flying helicopter was prompted by the introduction of a special helicopter service between the British Industry Fairs at London and Castle Bromwich, B'ham.

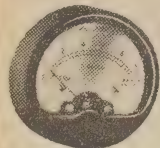


This is supposed to be a "safety-first" lesson to some local schoolchildren, but Mr. Childs has earned himself a black mark by knocking down two signposts with his remote-controlled car. Its erratic antics leave the girls highly amused, and the budding male drivers rather quizzical.

Homecrafts

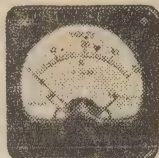
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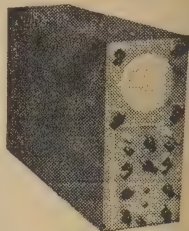
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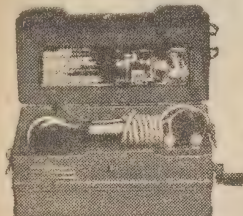
★ "RECORDEX" RECORD RACKS

The new improved gramo Record Rack, holds 25 10in or 12in records. Complete with index card and gummed identification numbers for records. Price as illustrated, 17/9.



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5in Tube + AC/DC Amplifier; + High sensitivity; + Wide frequency range. Price, as illustrated, £78, plus 12½ per cent sales tax. (Terms available).



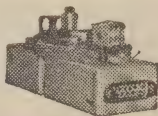
★ DISPOSAL BARGAIN

English Army Telephones, generator type with bell. No batteries required. Five mile range. As illustrated. Complete, only £4/17/6.



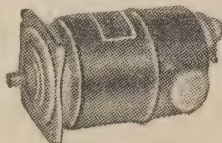
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Brand new American imported Eimac 100TH tubes. Reduced from 8 Gns to 49/6.



★ KAR SET

Radio and Hobbies Car Radio Kit as described in May issue of Radio and Hobbies. Homecrafts offer this kit complete to the last nut and bolt. Price, as illustrated 24 Gns. Including Sales Tax.



★ DISPOSAL BARGAIN

12 volt 500 watt generators. Completely reconditioned. Ideal for home lighting plants. Originally cost £50; price as illustrated, 10 gns.



★ VAN RUYTEN PORTAPAC

Any ordinary battery portable can be operated from the 230 volt mains. Price, as illustrated, £10/5/-.



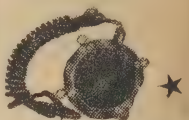
★ GRAMO NEEDLES

Golding superfine gramo needles. Ten playings for each needle. Plastic boxes of 100 2/2 box.



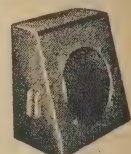
★ E.M.A. FLEXIBLE COUPLINGS

Polystyrene insulated, sizes ¼ x ¼, or ¼ x ½. Price, as illustrated, 3/11.



★ ENGLISH 104 CRYSTAL MIKES

104 Crystal Microphone with high fidelity crystal. As illustrated. Price £5/19/6.



★ STREAMLINED STEEL SPEAKER BOXES.

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★ I. F. BARGAIN

Brand new genuine Kingsley 455 Kc. I.F. Transformers. As illustrated, cut to only 8/11.



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NEWS AND VIEWS OF THE MONTH

Moon-ship scientists

THESE intrepid scientists who hanker after trips to the moon learn that Russia has also been doing some star-gazing.

According to the Russian paper Red Fleet, Russia is planning to make flights to the moon in a large rocket ship. The ship was disclosed by Dr. B. Abiant, a Soviet rocket specialist.

He said the design was for a 1000-ton rocket, 60 metres long, 15 metres in diameter, and powered with 20 liquid jet engines with a total of 350-million horsepower.

Dr. Abiant's article said the V-2 rocket used by the Germans in the last war had technical defects.

Dr. Mikhail Tikhonravov, of the Soviet Academy of Sciences told the newspaper Pioneer Pravda last week that a non-stop flight to the moon was probable within 10 or 15 years.

* * *

Links With The Past

ARCHAEOLOGISTS have been busy this month, and have discovered some interesting and significant links with the past.

From Tel-Aviv comes news that its modern concrete houses are constructed over the ruins of a civilisation 4000 years old.

Excavations over a hundred square metres north of the city have already been made by students associated with Professor Sukenik, of the Hebrew University. These have revealed an ancient fortress at Tel El Jerisheh, once the site of a Danite community mentioned in the Book of Judges.

The fortress is built on a skeleton framework of layers of rough, sun-baked clay bricks. The outside walls enclosing a network of small

chambers, are more than two yards thick.

From the outside walls, steep slopes run down to the foot of the mound. These were covered with a layer of sand in which tools of the workers have been found.

The steep inclines were effective against enemies, who would be mowed down if they attempted to scale the open slopes.

During the present digging, the archaeologists have found golden scarab sealing-rings, potsherds from Cyprus and Mycenae, and the hilt of a sword.

The scarabs are identical with those unearthed in the Egyptian centres of the Hyksos Empire.

* * *

Mr. J. M. Martin Retires

WITH the retirement of Mr. J. M. Martin, Assistant Director-General (Wireless), on September 27, the PMG Department lost one of their most experienced radio executives.

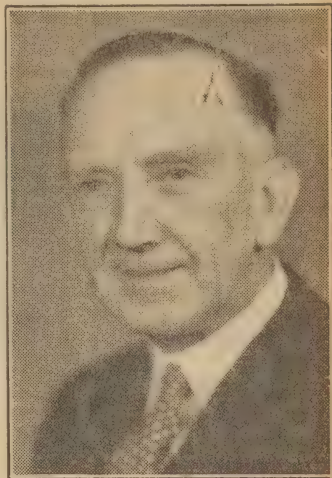
Mr. Martin, who was a native of County Kerry, Ireland, has been interested in radio all his life. In 1906 he was an operator at Lloyd's wireless station at Molin Head, Ireland, and later on, installed wireless stations for the Marconi Co. in England.

Mr. Martin came to Australia in 1913 at the invitation of the Commonwealth to assist in the construction of coastal wireless stations. Since that date he has been constantly connected with the growth of broadcasting, joining the PMG Department in 1920 when the control of coastal stations became its responsibility.

In 1923, Mr. Martin became Senior Radio Inspector, and in 1939, Chief Inspector (Wireless).

Most sections of the radio industry

have come in contact with Mr. Martin in some connection during his career, and all join in wishing him well during his retirement. His work has been of great value to the Department and to the country.



Mr. J. M. Martin

U.S. Indians Asiatics?

ARCHAEOLOGISTS working 900 miles apart have found more proof that the so-called American Red Indians were originally Asiatics.

They came to the North American continent via Russia and Alaska, according to Dr. R. S. McNeish, of the National Museum, at Ottawa, and Mr. Boyd Wettlaufer, a University

POPULAR SCIENCE QUIZ

Q.: Why was it, in a recent movie showing a trip by rocket-ship to the Moon, that when the rocket was out in space it seemed to be standing still and the crew, dressed in space suits, could even walk around on the outside?

A.: Movement can only be detected relative to something else. Generally we relate it to the Earth. However, the Earth itself is moving, and with high speed, in several different directions. One of these is its annual motion around the sun, at a velocity of 18.5 miles per second. When the rocket-ship is out in space, no other bodies are near and there is no atmosphere rushing by, so the ship would seem to be still just as the Earth does. Except for instrumental observations, the ship itself would be the standard to which other movements would be generally referred.

In the absence of atmosphere there

would be no slipstream to blow them off the surface and they were magnetic soles to assure attraction to the ship's hull.

Q.: Should a steam boiler for home heating be drained when it is going to be idle over the summer?

A.: If the boiler water remains clean, it is better not to drain it. It should be filled with soft water, but even hard water becomes soft after it has evaporated a few times. It is advisable to keep it alkaline, by the addition of about a quarter of a pound of anhydrous sodium carbonate (soda ash). This minimises rusting and formation of scale. Do not let the boiler stand empty of water over the off-heating season. However, if the boiler is filled at the end of the heating season, let the water boil for a short period, as this drives out dissolved oxygen.

Q.: What causes the great difference in the strength

of distant radio stations between day and night, and between seasons?

A.: Near a transmitter the waves travel directly to the receiver antenna, but farther away these "ground waves" are intercepted by the curvature of the earth. At a height of 30 to 250 miles there is a region called the ionosphere which bends the waves down again, and so carries them around the earth. The very short waves used in television are not ordinarily affected, and that is why they will not carry much farther from the transmitter than one can see. The ionosphere has several layers, made of atoms partially broken or ionised, mainly by the sun's radiation. The heights of these layers, and their relative effectiveness, vary between night and day and also from one season to another, so this affects long-distance radio transmission. Some frequencies are transmitted better at night, while others are most effective in the daytime.

The range of
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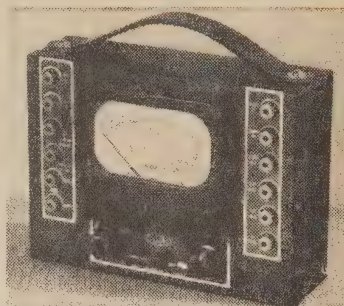
- Signal generators
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- Super tracers
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- Sequential exploders
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- Reverse current relays
- Earth resistance testers
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This A.C./D.C. Multimeter Kit comes to you complete with everything right down to the last nut and bolt. It is carefully engineered and designed and all Resistors, Shunts, Meters, etc., are carefully pre-calibrated in the Factory to an accuracy of 1 per cent. Thus when you complete building this instrument there is no further calibration necessary. It has a wide range of A.C. and D.C. voltages up to 1000 volts and current can be measured in the following ranges:—

1, 10, 50 and 250 Milliampères.

It is entirely self-contained for resistance readings which are up to 100,000 ohms.

It uses the popular 4" square type Meter with a clear Multi-Scale. All wiring instructions and constructional details are given with the Kit, and photographs and circuit diagrams make it simple. A completely illustrated well written Booklet of Instructions accompanies every Kit, and your guarantee of satisfaction is in the name "University."

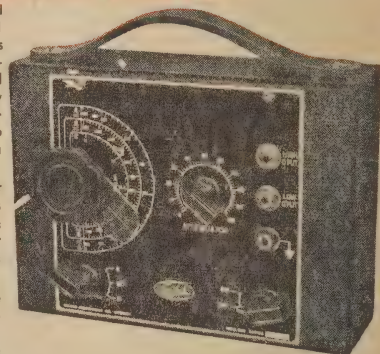
The size is 6" x 8" x 2½", and it's an exact physical replica in size to the Model OK1 Oscillator Kit, which is its companion.

MODEL OK1 OSCILLATOR KIT

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Standard Batteries are used and each OK1 Kit is complete with an Instruction Book which gives pictures and wiring diagrams of all parts and in addition gives full operating instructions for using the Oscillator to the best advantage when you have finished it.

It is carefully packed and all Metal Parts are pre-calibrated so that no heavy work has to be done. Pleasing in appearance yet effective and simple in its use, it makes an ideal Portable Battery Oscillator for the Serviceman or Home Builder.



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of Minnesota graduate who is working for his Doctorate in Philosophy by probing the ruins of ancient Indian camps.

Both men theorise that the Red Indian is, in fact, the descendant of wandering Mongolian tribesmen, who wandered as far as the Bering Strait.

There they found an ice-bridge which allowed them to cross the 50-mile gap. This probably happened during the last ice age (about 10,000 years ago).

Once in Alaska, the tribesmen turned south through the Mackenzie River basin to all parts of the continent.

Dr. McNeish's research was done in the desolate wastes of Canada's north-west territories.

Mr. Wettlaufer's trek took him in a broad arc from the border of North Dakota to the forest line in northern Saskatchewan.

This walkabout was sponsored by the National Museum at Ottawa and the Saskatchewan Department of Natural Resources.

It was so successful that big-scale excavations will start next year.

Wettlaufer found or revisited 205 sites of prehistoric Indian relics. He looked at or photographed 9000 bits and pieces.

At Mortlach in Saskatchewan he uncovered a midden (settlement) which had five levels (the lowest about 9000 years old) built one on top of the other as floods or decay ruined the earlier encampment.

"My discoveries dovetail with those of Dr. McNeish," Wettlaufer said.

Button Up Your Heart

SCIENTISTS are using nylon and lucite buttons for closing holes in hearts. They literally button up hearts with holes in them.

The holes, which are present at birth and are most common in heart malformations in young adults, appear in the wall dividing the two upper blood chambers of the heart.

Cures For Cancer?

SOME mention of cures for cancer have appeared in the news this month, although very cautiously reported, particularly by the medical profession.

One of these comes from London—attributed to Dr. Geoffrey Hadfield, of the Royal College of Surgeons.

Dr. Hadfield said scientists had found that certain encephalitis germs had killed cancer cells in small animals.

The germs gave the animals only mild symptoms of encephalitis.

Dr. Hadfield said: "It may not be unreasonable to hope that we will eventually find a virus that will destroy human cancer cells, leaving normal cells unharmed.

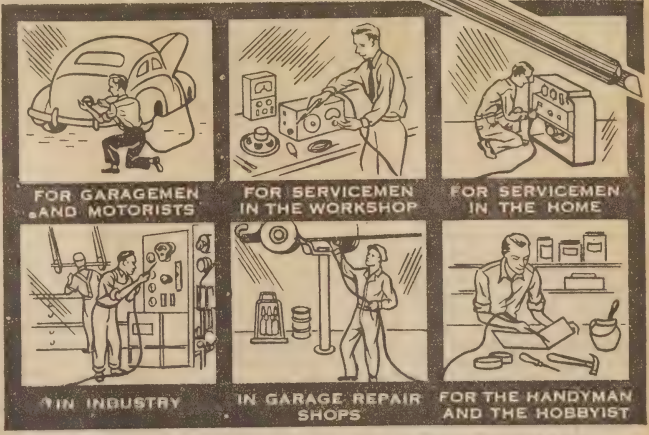
"I believe we are in sight of success in this direction."

LP and Broadcasting

AS anticipated, the LP record has proved a "natural" for broadcasting. If record changing was a nuisance in the home, it has always been a nightmare to the announcer who likes to achieve a smooth change-over. The number of sessions on the air grows daily.

A special commendation to 2SM who broadcast the full "Carmen" complete with five minutes silence between acts. In commercial circles, it takes courage to see all that time go by without a minute of it sold! But the listeners were impressed."

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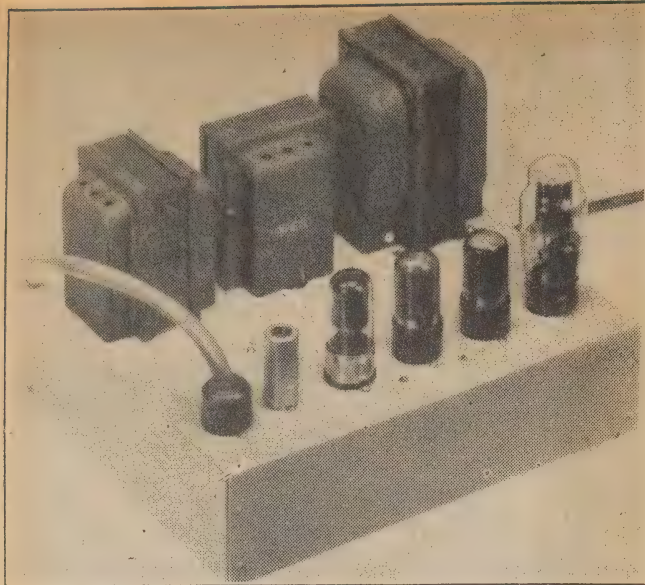
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The Playmaster No. 2 is built on the same chassis as the No. 1 described last month, and the general layout is the same.

of which is instability. There is no objection at all to using a better amplifier than is needed if one can pay for it and make it work. But when we describe a job in our columns, we like to be sure that it can be duplicated by the expert and not-so-expert, with a more-than-reasonable chance of complete success.

We also feel that the time is right to review the amplifier position in terms of layout. New record types and standards, and new pickups, have made some kind of compensation and variable frequency control an indispensable part of the amplifier design.

WILL DO BETTER

And so we have decided to "re-state" the position in a series of circuits which will cover a wide field, will be more than adequate for present-day needs and equipment, and which we think have no particular "bugs" to send our readers white-haired!

Although I have estimated a satisfactory working range for all parts of the equipment as 50-15kc (much

A TEN WATT PLAYMASTER

This month's amplifier is substantially the same as the Playmaster No. 1, but uses less expensive and more standard equipment. Its performance is of a high standard, and it plays with perfect stability with any type of input. It will probably be the most popular of the Playmaster series of amplifiers.

IN building up last month's design, we used as a basic kit the power and equipment and output transformer originally designed for the "Williamson" amplifier. The results were exceptionally fine, but somewhat more expensive and ambitious than will be required by probably the majority of our readers.

Perhaps it should be stated again that the idea behind this series of amplifiers is to produce designs combining a high degree of reproduction with reasonable cost, simple construction and freedom from "snags."

PERFORMANCE AND PRICE

In the last 20 years or so, we have built and tested many amplifiers, large and small, good and bad. One lesson we have learned from all this is that there is little point in spending time and money chasing a standard which is higher than that required for a given purpose, and which is not likely to be a factor in improving our results.

There has been something of a fashion in recent years to produce amplifier designs about which there is much heartburning if full power is not available, for instance, at 15 cycles per second, or if the response begins to taper off at 17kc, or if there

is a few degrees phase shift from input to output.

As a result, we have seen some most ingenious and completely creditable jobs built which are very near perfection up to 60kc and down virtually to zero. They have quite a number of special applications which, I suspect, lie substantially behind their development. In other words, they are made and sold for purposes other than just playing gramophone records in the home.

One such an example is the "Williamson" amplifier—so well known that many have the idea that it is the only "super" amplifier circuit ever developed. The truth is that there are a number of fine amplifiers made and sold all over the world, all having a performance substantially of the same order.

We have found, and many readers have found, that building these jobs often brings many difficulties, chief

to the wrath of one or two correspondents), all the amplifiers we will describe will do better than this. As such, their performance and distortion figures will be much superior to any other link on our reproducing chain.

Last month's amplifier was, in fact, the job I use myself, together with its simple control panel for giving compensation for various records. In order to demonstrate that substantially the same results can be obtained with more modest equipment, I have built up this Playmaster No. 2, which is interchangeable with the No. 1.

The main difference between the two amplifiers as far as results go is that, whereas the 807 job had a maximum output of about 20 watts, this one runs to only 10 watts.

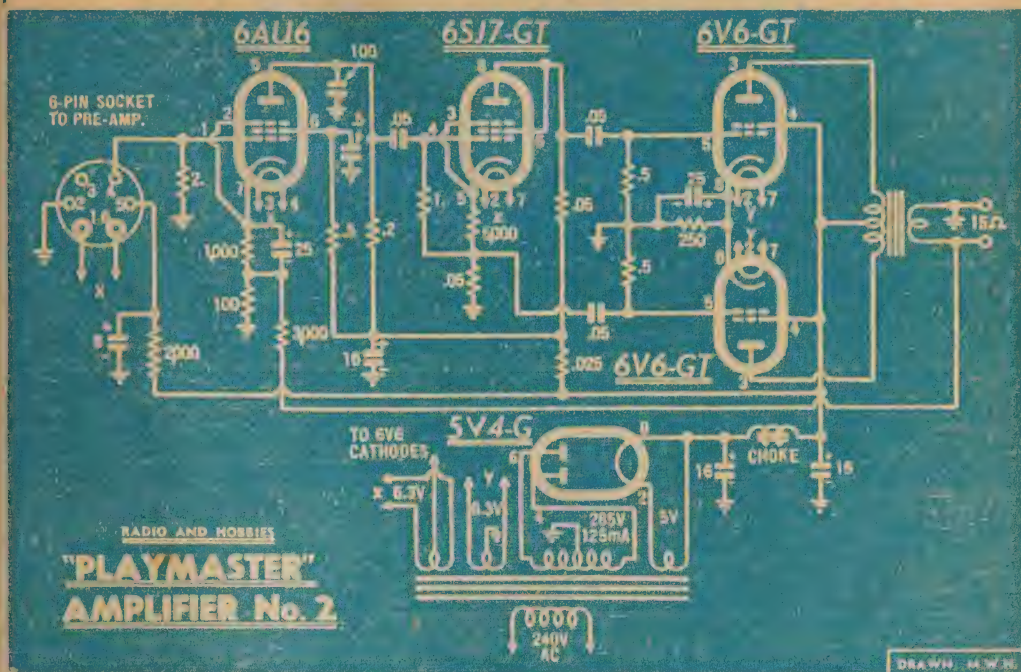
USEABLE OUTPUT

That sounds a lot on paper, but in fact it isn't such a difference as it sounds.

My big amplifier wasn't specially built to have all that output, nor is it often used. It's good to have plenty in reserve, and will allow those who want big output to run perhaps 7 or 8 watts average without danger of overload. Personally, I don't use more than 4 or 5 average,

by
John Moyle

CIRCUIT DIAGRAM OF THE PLAYMASTER No. 2



which is all I can stand with an efficient speaker system.

With this amplifier, you would be quite safe averaging 3 or 4 watts with enough in reserve to drive you from the room on the loud passages. I know this is a very loose way to talk about output, but it's one way to give some sense of proportion. This is probably the optimum-sized amplifier for big rooms and small halls, and should be the most popular of the whole series.

Many of you will already have used push-pull 6V6 amplifiers, and will therefore know already just how much noise they make.

In selecting operating conditions for the output valves — and these were selected for their universal acceptance and ready availability — we looked for high output, low distortion and voltages which could most easily be obtained from standard equipment.

We were most impressed by a rating which uses 285 volts on plate and screen, thus avoiding screen dropping resistors, about 100 mills total high tension current, and a load of 8000 ohms for 3.5 pc distortion.

PLATE VOLTAGE

This supply can be obtained from a standard 285 per side 120 mill power transformer using a 5V4 indirectly heated rectifier, with enough reserve current in hand to operate

a control panel and tuner if we so desire.

In fact we used a 150 mill transformer (because we couldn't get a 120 mill type in a hurry!), and this gave a little more voltage. In practice, we have found anything up to 300 volts is not likely to damage the valves. Remember that the 285 plate volts referred to must be measured between plate and cathode pins of the output valves, and not between H.T. and chassis.

The use of such a comparatively low plate voltage makes filtering quite simple. Two 16 mfd 525v (or 600v) condensers are used across the rectifier, and another 16 mfd condenser after the filter choke. There is no need to use any further filtering here.

Although we used pigtail type con-

As this series will deal with a number of interchangeable amplifiers, control units, and tuners, readers are advised to read each article in conjunction with others in the series. Not only will this enable us to avoid too much repetition of material, but it will assure that they do not miss any later information applicable to some of the earlier articles.

densers, the chassis will be made punched with holes to accommodate chassis-mounting condensers if you have them. Results are the same.

The phase changer valve was a 6SJ7-GT, connected as a triode. As for last month's design, almost any triode valve can be used here, such as the 6J5 or one half a 6SN7. The only changes will be to the socket connections, which must be appropriate to each valve.

Once again the first amplifier is a 6AU6, wired as a fairly high-gain pentode.

The overall-gain of the amplifier and its distortion are reduced by using inverse feed-back from the voice coil to the cathode circuit of the 6AU6, as in last month's circuit. With the values given, the feedback is approximately 20 db, which is just about as much as it is wise to go, consistent with stability.

OUTPUT TRANSFORMER

The total distortion of the amplifier under these conditions should be well below 1 pc, particularly when operated at low volumes. Because of the fact that distortion percentage rises rapidly as maximum output is approached, even though this maximum be a low figure, ample reserve power is particularly valuable.

A word here about the output transformer. This is likely to be an

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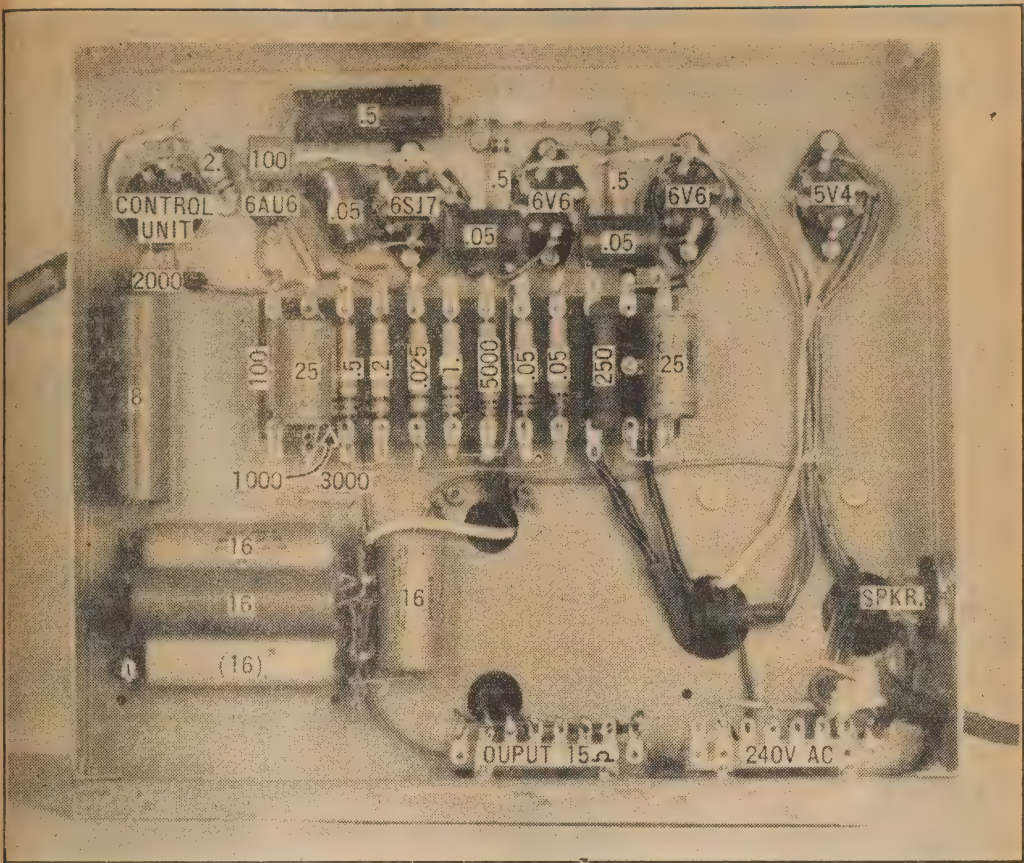
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UNDERCHASSIS PHOTO SHOWS PLACEMENT OF PARTS



Here is an underchassis picture of the amplifier showing location of all components. The filter condensers may be chassis mounting types if desired. Note the logical progression from input to output, the power equipment being well away from the input.

expensive item, and some idea of the difference between an ordinary PA type and a de-luxe type would be in order.

In order to compare them, we operated the amplifier first with an ordinary PA transformer, and then with a high-grade super-fidelity type costing nearly twice as much.

With the PA type—actually an QP58—we found that, without feedback, the maker's frequency range was substantially correct. The bottom end had begun to fall several db down at 50 cycles, and also started a droop somewhere about the 8 kc. mark.

DIFFERENT STORY

When feedback was applied, however, there was a very different story. The frequency response was now quite flat from 50-20 kc! Below 50 cycles the output showed a slight rise, probably due to phase rotation in the transformer, and above 20 kc. it rose to a peak at 40 kc—nearly 6 db.

This peak was probably due to an-

other phase rotation and was responsible for some high frequency oscillation at high outputs, unless a bypass was wired from the plate of the 6AU6 to chassis.

The use of such a condenser is standard practice in such amplifiers, and for the same reason. With a value of .00025 mfd the 40 kc peak was very greatly reduced, and the oscillation completely cured.

This value of condenser is not enough to cause any appreciable high frequency drop below 20 kc. and its effect on response is therefore negligible.

With the OP63 transformer, quite a different behaviour was noticed in the super-sonic region up to 50Kc. The peak noticed with the PA type was not nearly so prominent, nor was there any tendency to oscillation. For this reason we have specified a .0001 6AU6 bypass condenser in the plate circuit, and that is used merely to flatten the curve in this region, thus slightly improving the wave-form.

Don't worry too much about this talk of oscillation. In many cases

it won't occur at all, but it is one of the things a designer looks for on a precautionary basis. I can cause unpleasant effects on the high frequencies at high volume if not guarded against, particularly if the pickup has a peak in the upper region, and is likely to "shock" the circuit into oscillation on loud passages. The chances are that you won't notice any difference by listening tests with either value. It should not be necessary to go beyond .00025, however.

SENSITIVITY

Under these conditions, the amplifier showed an output at the voice coil of a fraction over 10 watts down to 50 cycles and up to the middle range. However, this undistorted output figure dropped to about 8 watts at 10Kc, probably due to the leakage reactance of the transformer. The drop was maintained at frequencies higher than this.

For average listening, it is debatable whether this drop would be serious, and it could only be so when

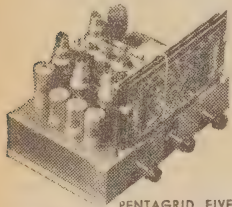
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PENTAGRID FIVE

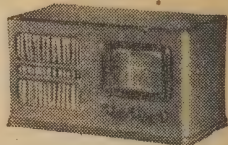
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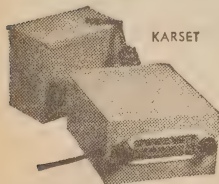
1950 RADIOGRAM



CARRY SET



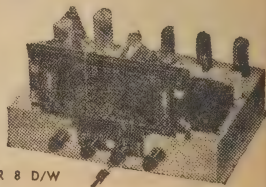
FIRESIDE 5



KARSET



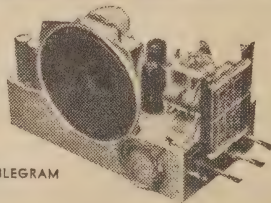
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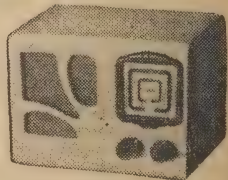
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the amplifier was operated around its maximum limits. However, I think it is worth using a better type transformer in order to ensure our operational limits of "flat to 15 kc" are observed.

A type such as the OP63 would be adequate, and shows no appreciable drop in output until well beyond the audible range. The OP25 or its equivalent is even better, but can be regarded as definitely de-luxe.

The fact that our measured output is a little over 10 watts rather than the rated 14 is accounted for by output transformer losses, &c., and is quite an expected figure. The better output transformers will show a little loss, but the figure of 14 is an ideal calculated figure relating to plate-to-plate output.

The improvement in frequency response noted when feedback was applied using a PA type, is due largely to the fact that the transformer itself is included in the feedback loop. Poor output transformers, however, should not be used with this circuit. The PA types referred to are quite good, general purpose types, but undoubtedly the optimum quality would be the "30-15 kc" types, which are ideal for the purpose and will give full output over this entire range.

OUTPUT LOAD

Although the stated load for the 6V6's on this voltage rating is actually 8000 ohms, a 10,000 ohms transformer is quite OK. One need not take these matching figures too literally. They are calculated values, and one must also allow reasonable latitude in component design which will affect power output and distortion—the main points influenced by matching. Purists may raise their eyebrows a little at this, but I doubt whether the practical engineer will do other than agree.

Incidentally, power output with the better transformer was constant over the range 30-15Kc, and was also a little higher than with the PA transformer—actually about 11½ watts. This represents very good efficiency, and should be approximated in your own gear.

The amplifier is built on the same chassis as for the Playmaster No. 1. The valves are all in line, with a 6-pin input socket next to the 6AU6. All resistors except the 6V6 grid resistors are mounted on the terminal strips under the chassis. A few terminal strips anchor other pigtail connections. The strips at the rear anchor the mains input tappings, and output transformer secondary tappings—this one being a multi-ratio type. Actually, there is very little to it—we built it in a couple of evenings.

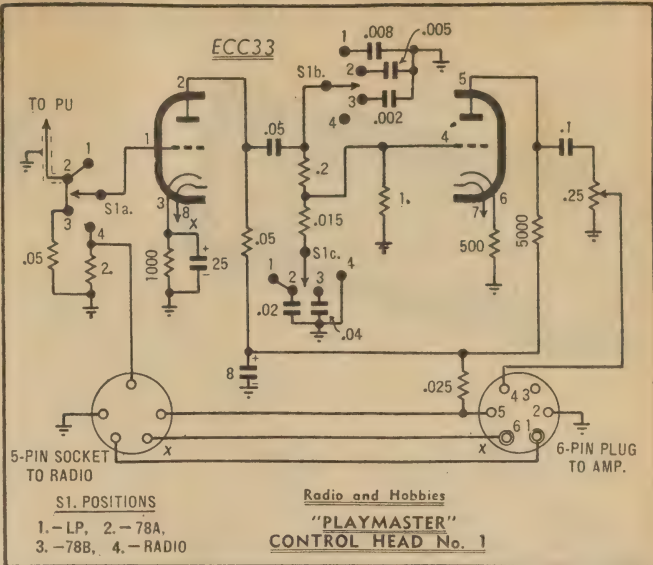
SENSITIVITY

The amplifier has an input sensitivity of .35 volts, which is better than the 807 job. It works perfectly with the control unit No. 1 described last month, the circuit of which is reprinted herewith. It contains a grid resistor in the second half of the 6SN7-GT, which unfortunately escaped notice in last month's issue, and was omitted.

Under these conditions, the amplifier No. 2 is just as free from hum as was its predecessor, and in every way sounds just the same.

The feedback resistor value is given for a 15 ohm voice coil speaker. For 8 ohms use 2000 ohms feedback

CIRCUIT OF CONTROL HEAD No. 1



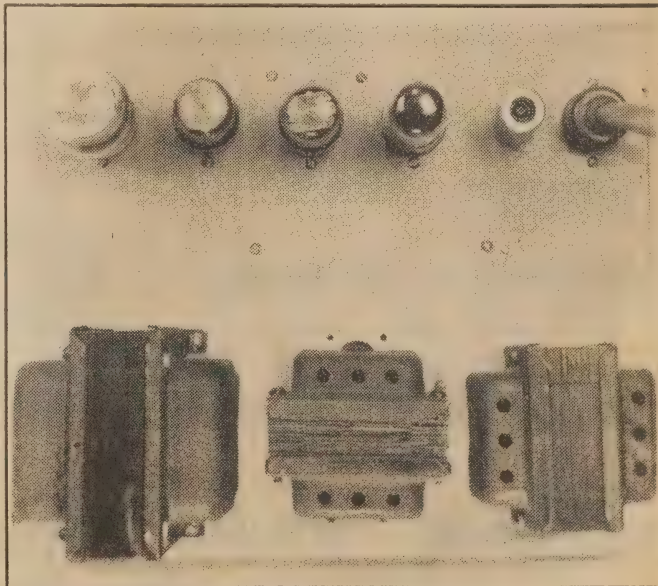
The circuit of the No. 1 control unit described in detail last month. In the original diagram, a 1 meg resistor from the second grid was unfortunately omitted. A piece of 72 ohm co-axial cable is used to connect pin 4 to the main amplifier because of its low capacitance.

resistor, and for 2.3 ohms a 1000 ohms resistor.

Note the extra decoupling for the control unit. In the original Playmaster, this unit was fed from the output valves' screen circuit which provided decoupling via the screen

dropping resistor. The extra filtering has a useful effect on residual hum, and is successful in removing all but an infinitesimal amount.

The underchassis photograph is reproduced at about half actual size to help you in your layout. The use

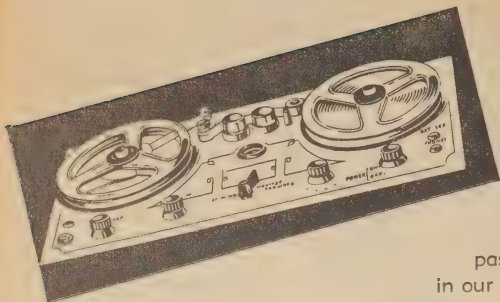


This top view shows the valves, left to right—5V4, two 6V6-GT's, 6SJ7-GT, 6AU6, and input socket. The power transformer is at bottom left, then the output transformer, and the choke at the right.

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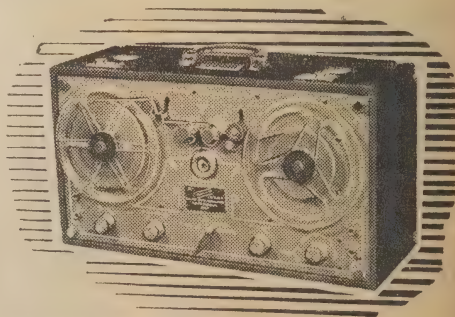
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of the terminal strip is a great assistance and also a time-saver, as it can be wired up before mounting to the chassis. It is supported on a couple of long bolts through the chassis, and either held between two nuts or by a couple of spacers.

I suggest that you wire up the filament and power circuits first of all, making sure that the centre-tap of the appropriate filament winding is connected to the 6V6 cathodes. This positive bias helps to avoid heater-cathode hum in the initial stages. Don't forget to earth the centre tap of the 6V6 filament winding, or one side of it if no centre tap is provided.

Although not all the resistors need be of 1 watt rating (apart from those shown as wire-wound), it is best to use these rather than the $\frac{1}{2}$ watt types to be on the safe side, as when carrying current the larger resistors are more reliable.

RESISTOR RATINGS

In the pre-amplifier, unfortunately, this isn't always possible without unduly cramping matters. At any rate, spend a few extra pence for the best resistors you can buy. In certain positions they can create mysterious and annoying crackles and rustling noises if faulty, and these are often hard to find. The wire-wound resistors should be of the 5-watt type. These are the cathode resistor for the 6V6's and the 2000 ohm decoupling resistor (although the one shown in the picture is a 1-watt).

A word about the pre-amplifier control unit may be of interest. The bass boost circuit is a standard voltage-divider type, but it may be unfamiliar to some of our readers.

If we regard the unit as being switched to position 4, it will be seen that there are two resistors—of .2 and .015 meg—in series from the first triode plate to ground. The output for the second stage comes from their junction.

The effect of this is to make available only portion of the output voltage—actually in the ratio of .2 to .015, or about 13-1. In position 4, this reduction applies to all frequencies.

In position 3, however, you will see that a condenser of .04 mfd has been included at the bottom end of the circuit.

At all frequencies above about 1000 cycles the impedance of this condenser is very small as compared with .015 megs, so that its presence can be neglected. But from 1000 cycles down, the impedance of the condenser becomes important. At 500 cycles it is twice the impedance at 1000 cycles, and at 250 cycles four times, and so on.

VARYING IMPEDANCE

Thus we have added to the effective value of the .015 resistor so that the total impedance of the bottom half of the divider is increased. At very low frequencies it will be much higher than .015. At 30 cycles, for instance, it adds about 130,000 ohms to the leg, which means that the reduction in voltage available is now only about 2-1 instead of 13-1. At 1000 cycles its impedance is only about 5000 ohms.

The net effect of all this is that the voltage available from the first triode section increases as the frequency decreases, giving a boost to the bass.

The use of a smaller condenser than .04—note that only .02 is used

in positions 1 and 2—has the effect of bringing in the bass boost at a higher frequency. Both LP and American 78 records require a boost that starts at about 1 kc, while British 78 records don't need boost until about 300 cycles. The values given provide approximately for this, as revealed by the curves published last month.

The fact that the boost starts earlier in positions 1 and 2 means that we get more boost at the extreme bottom end. This is also in order, as both types of records concerned also need more boost.

In practice, there are a few design features which limit the amount of boost to something less than the calculated value. The amount of boost is primarily a function of the initial ratio between the two resistors, so that, in deciding on a given bass rise curve, one must consider the net effect of both the resistor ratio and the condenser value.

If you are interested, it is quite fascinating to vary them both and note the changes in the amount of boost and the point in the curve where it becomes appreciable.

TWO POINTS

Two other points must be watched in this circuit. One is that the effective value of the voltage divider resistance at low frequencies must be about 10 times that of the plate resistor which feeds it, and the following grid resistor must be much greater than the effective impedance at the lowest frequency concerned. If it isn't, the effective impedance of the whole circuit won't be able to rise high enough to give full boost. Another method of obtaining boost which has a number of advantages is to apply feedback to the valves concerned, and then to arrange for the feedback to be increased or reduced at the upper and lower frequencies to give either treble or bass control.

This method is quite attractive, particularly when the second triode is used to give additional frequency compensation to supplement the fixed value. In this case, however, the first triode section is handling such small voltages that the more orthodox circuit is quite adequate and perhaps less tricky, and introduces very little, if any, distortion.

In our next issue we hope to describe a more elaborate control unit which includes this extra compensation.

VOICE COIL CONNECTION

It is important that the feedback connection be made to the right side of the voice coil winding. Which is the right side? You can only find out by trying.

If the connection is OK, there will be a decided reduction in amplifier gain when the feedback is wired in. If it is the wrong way round, you will get positive instead of negative feedback, and the amplifier will probably emit the most horrifying screams. Therefore the best way is to get the job going without connecting the feedback, and then touch the connecting lead to the voice coil and see what happens. Don't forget that the other side of the winding must be connected to the chassis. Wrong connection makes a great deal of noise but won't do any harm.

Once the correct wiring has been ascertained, the lead is of course permanently soldered in place.

FERRIS Electric TRAINS

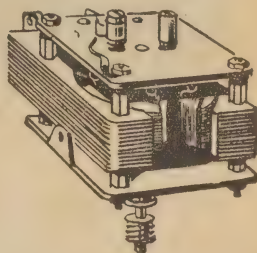
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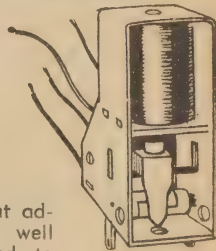
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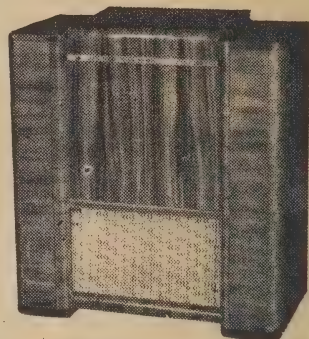
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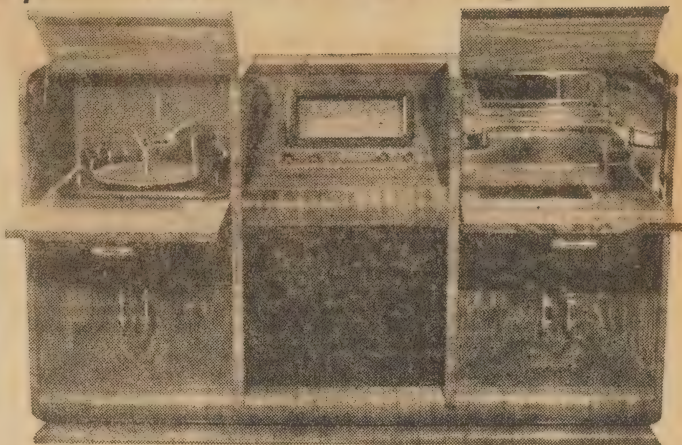
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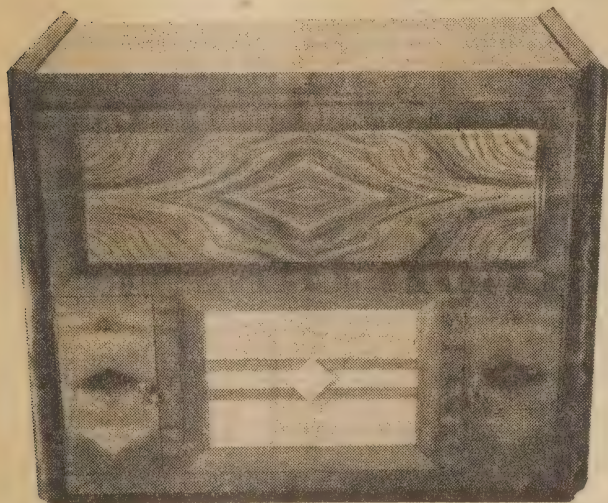
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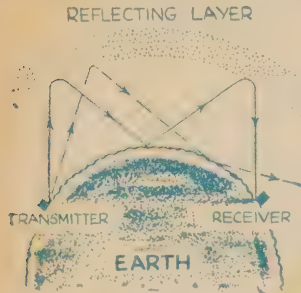
Here's your answer, Tom!

A shiny new triple wave receiver was the inspiration for Tom's questions this month. Apparently he has spent some time tuning around the dial on all bands with a result that his curiosity has been aroused about broadcast and short wave. His queries will be of interest to everybody who owns a radio receiver.

TOM has noticed that, at certain times of the day he cannot receive much on the short-wave band while, at other times, the band is crowded with strong signals from distant parts of the world. He asks:

TERMS EXPLAINED

What is the difference between broadcast and short wave? The use of the term "broadcast" may be a little confusing, Tom. Strictly, it could be applied to short-wave and ultra shortwave with equal justification, because, after all, short-wave stations "broadcast" their pro-



grams, too. Common usage has made it synonymous with medium-wave or the wavelength used by radio stations to broadcast programs to listeners in their immediate vicinity. Incidentally, while we are in the mood for clearing up definitions, it is often more convenient to talk about frequency rather than wavelength. Radio waves always travel at a speed of 300-million metres per second, so that, knowing the wavelength, you can calculate the frequency, and vice versa. For example, a wavelength of 300 metres corresponds to a frequency of 1-million cycles per second, while a wavelength of 30 metres corresponds to a frequency of 10-million cycles per second. To save writing all the 0's we usually put 10 megacycles per second, or just 10 Mc.

It is important to understand this, because there will be numerous occasions when you will know the wavelength of a station but will need to convert it to frequency in kilocycles or megacycles, in order to find its position on the dial.

To answer your query, Tom, the broadcast band extends from 550 to 1600 Kc, while "shortwave" could

mean anything higher in frequency. Most dual-wave sets cover between about 6 and 20 Mc on the shortwave band.

Why do the short waves travel over longer distances than the longer waves? It's just one of the tricks of nature, Tom. In the days before much was known about radio, it was thought that the longer the wavelength the further the signals would travel. Commercial interests took charge of the long waves and left the short waves for amateurs to play with, thinking that they would not be able to transmit more than a few miles.

However, the same commercial interests were amazed to find that the amateurs, using the shorter wavelengths and low power, were able to transmit over longer distances.

SIGNALS REFLECTED

I believe radio waves travel in straight lines. How, then, do short-wave signals travel around the earth? You may, or may not, know that there are a number of layers capable of reflecting radio waves miles above the earth. Signals travelling long distances around the earth make use of these reflecting layers in the way we have shown in the diagram. Long distance communication would not be possible without the reflecting layers.

As you can imagine, there is some energy lost each time the signal is reflected, so, where maximum range is required, the idea is to shoot the signal off from the earth's surface at as small an angle as possible, so that there will be few reflections necessary.

Experience has shown that the higher frequencies tend to be reflected more efficiently than the lower frequencies, so that, with a certain transmitter power and a certain number of reflections, the signal from the higher frequency transmitter will be louder. Or, looking at it another way, it is necessary to have high power to get long range on the low frequencies.

Unfortunately, there is a limit to the upper frequency which can be used for long distance communication, because, at very high frequencies, the upper layer ceases to be a reflector and the radio waves simply continue on into outer space, never to be heard again.

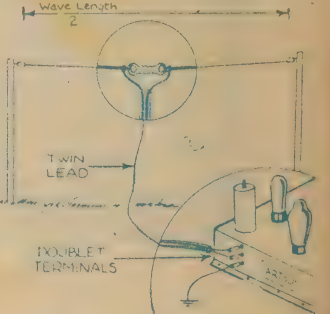
This does not mean that the very high frequency waves are of no prac-

tical use. On the contrary, they are extremely useful where it is required to send strong signals over short distances with relatively low power. FM, television and many of the mobile radio telephone networks make use of the properties of VHF. In general, these waves tend to travel only to those places which are visible from the aerial, although, for special reasons, which are too lengthy to discuss here, they do travel to places which are not actually visible.

CHOICE OF FREQUENCY

Why do overseas shortwave stations sometimes use different frequencies at different times? As we said before, there is a certain frequency above which the radio waves will not be reflected, and at the same time the higher the frequency the more efficiently the wave will be propagated. To make things even more complicated, the highest frequency which the upper layer is capable of reflecting is subject to frequent variation, depending on the time of day and the season.

Thus, if an engineer in London wishes to send the strongest possible signal to Sydney, he would choose a frequency a little lower than the highest frequency capable of being reflected. He may also use "beam" aerials, &c., but at the moment we



are mainly concerned with the significance of the frequency.

Research laboratories throughout the world have put a great deal of time and effort into the study of the behavior of radio waves and, as a result, they are able to predict with great accuracy which frequency will be best for communicating over a particular path at a particular time.

LOCAL STATIONS

How is it then that a broadcast station can stay on the one frequency? The position is quite different in the case of broadcast stations operating on the medium frequency band. The engineer is concerned mainly

with sending a strong signal to all radio sets, within 100 miles or so of the transmitter. If his signals happen to travel interstate, that is all to the good, but he is not likely to be disturbed if they don't.

After all, a Sydney furniture store is not much interested in the fact that its advertising "blurps" were heard in Melbourne, because Melbourneites have plenty of furniture stores of their own. With this in mind, the broadcast engineer deliberately designs his aerial to concentrate the energy in the vicinity of the transmitter, at the expense of long distance transmission.

Of course, this does not mean that broadcast signals do not travel long distances on occasions, but the broadcast engineer could send much stronger signals interstate if he wished.

Why are interstate signals on the broadcast band stronger at night than during the day?

The ionosphere, or reflecting layer, we talked about earlier is affected by the rays of the sun. During the day it absorbs rather than reflects the medium frequency radio waves so that the only waves that reach listeners at useful strength are those that travel over the surface of the earth and, of course, these are strong only in the near vicinity of the transmitter.

At night, the absorption becomes less and the signals are able to be reflected from the ionosphere and, by means of successive reflections, can travel over quite long distances. The more power the station engineer can feed into his aerial, the greater the distance his signals are likely to be heard, but broadcast stations, even with specially designed aerials, can never transmit strong signals over great distances to compete with the short-wave stations.

Given a good receiver and aerial and a low local noise level, it is possible, in Sydney, to hear quite useful signals from places as far distant as Perth, in WA, or New Zealand, at night. Some of the powerful broadcast stations on the west coast of America are occasionally heard in Australia during the early hours of the morning, after the local stations have closed down. At this time most of the path between here and America is in darkness and the ionospheric absorption is least.

Some of the broadcast stations in America use aerial power of 50,000 watts or more, compared with 1000 watts for most Australian stations, so that they have a much better chance of being heard here than Australian stations have of being heard in America.

SHORT-WAVE BANDS

What are the main characteristics of the various bands?

We have already discussed the broadcast band, so that the next higher bands you are likely to be interested in are the 49 and the 42 metre bands. Most of the territory between these and the broadcast band is occupied by commercial communication stations or local services, often using morse or some other form of code transmission, and not of much interest to the general listener.

The 49 and 42 metre bands are excellent for transmission over medium distances at night. They are much used for conveying programs to the outlying areas of this country, where

the signal strength is much greater than that of even the most powerful broadcast stations.

The 31 and 25 metre bands are useful for world-wide transmissions over the greater part of the year and you will probably find the greatest concentration of interesting stations within these bands.

To a lesser extent the same applies to the 19 and 16 metre bands, although the latter tend to be subject to more sudden changes in transmitting conditions. When conditions on these bands are good you may hear stronger signals from overseas stations than on the lower frequencies.

When conditions are right, very strong signals can be heard on the 13 metre band, but, unfortunately, this band is subject to very sudden changes and, for this reason, is not used to the same extent as the 31, 25 and 19 metre bands.

Another point is that, for efficient reception on the 13 metre band, a fairly specialised receiver is required. Ordinary dual wave receivers, even those including a stage of RF amplification, show a marked falling-off in performance at wavelengths below about 16 metres.

A point that arises out of this is that, if you are building a dual wave receiver, Tom, there may not be much point in including the 13 metre band, but rather make 16 metres the lower limit and take advantage of better coverage at the other end of the band.

AERIAL CONSIDERATIONS

Bearing in mind that I wish to listen on all bands, what type of aerial would you recommend?

Any aerial you put up will have to be a compromise and, quite frankly, we think your best plan is simply to erect a wire, about 50ft long, as high as possible, and run a lead-in from one end to the set. Where the lead-in touches the building, &c., it should be insulated, or, better still, use insulated wire for the lead-in as a whole.

An earth wire is not always essential with a mains-operated receiver, but it sometimes helps to reduce certain types of interference.

However, if you become particularly interested in the 25 metre band, for example, you could make a special aerial, to be resonant at this frequency. In order to be resonant, the aerial has to be cut to an electrical length of a half wavelength, which would be 12½ metres, in this case.

However, for reasons which are too lengthy to discuss at the moment, Tom, the physical length of an aerial is only about 95 pc of its electrical length, so that you would make the aerial a fraction less than 12 metres in length. Converting metres to feet (1 meter equals 39.4in), we find that the aerial has to be 39ft long approx.

RESONANT AERIAL

There are several ways of feeding the energy from the aerial to the set, but we would suggest that you break the aerial in the centre and connect one wire from the end of a piece of twin lead to each of the quarter wave sections thus formed. Use a small insulator to hold the two sections of the aerial together at the centre.

The twin lead may be ordinary plastic power flex if nothing better

(Continued on Page 103)

N.H.V. KITS

AMPLIFIER CABINETS



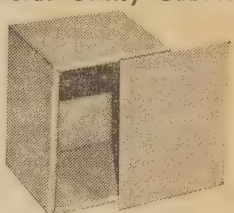
These streamlined amplifier foundation units consist of a standard chassis 3" deep with removable top in aluminium. Fitting over the top is a removable cover which has louvres on all sides and handles welded to the ends. Color Grey.

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AC3	17	7	9	£2 3 0
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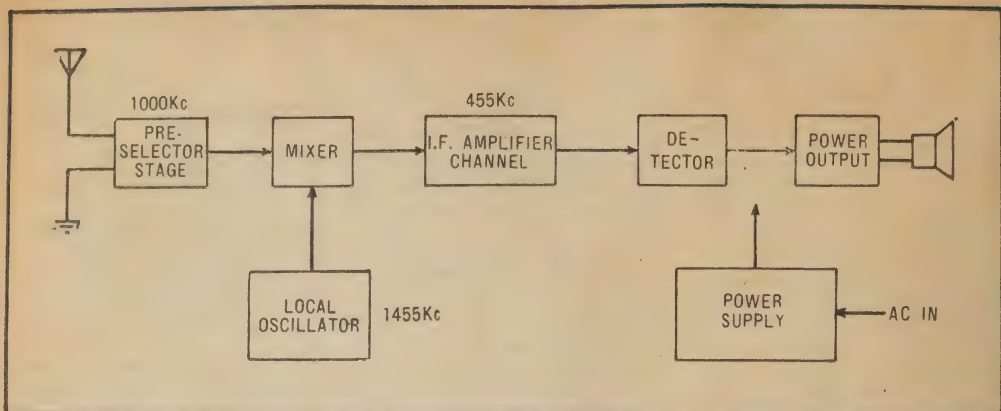
Catalogue No.	D	W	H	S. Tax
MC666	6	6	6	8/3
MC596	5	6	9	9/4
MC7810	7	8	10	13/9
MC6712	6	7	12	13/9
MC81010	8	10	10	17/-
MC81112	8	11	12	21/-
MC7915	7	9	15	21/-

SLOPING FRONT

Catalogue No.	D	W	H	S. Tax
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MCSF796	7½	9	6½	13/9
MCSF7116	7½	11	6½	16/-
MCSF8138	8½	13	8	19/3

N.H.V. KITS

An Associate of R. H. Oxford & Son Pty. Ltd.



This simplified block diagram will help you to follow the various processes involved in the superheterodyne principle. Using modern valves it is possible to combine some of the separate functions shown into a single valve.

LEARN WHILE YOU BUILD

"What is a superhet?" is a question our beginners frequently ask, and this month we are taking time off from building to introduce you to this popular method of reception. Also we give you a brief insight into the design of a simple superhet which we intend to describe for you next month.

WE intimated in our September article that the limit of performance for two ordinary valves had just about been reached, whether we used the single tuned circuit with regeneration, as in August, or two tuned circuits in a reflex arrangement as in September.

This being so, we must once again ask ourselves if the performance of these sets is good enough and, if not, where do they fail. Assuming that we do need something better, it looks as though we will need one more valve at least, but the question arises as to how best this may be used.

Some of you probably know the answer to the first question already and could point out that in your particular locality you have difficulty in receiving such-and-such a station, or worse still, in getting rid of such-and-such a station. In short, the set lacks sufficient sensitivity and selectivity for what may be termed "difficult" locations.

DESIGN

Furthermore, in the case of the regenerative set at least, non-technical members of the household may not adjust the controls for peak performance. We want a more simple and foolproof system of controls.

So much then for what is wanted. Now comes the problem of how to get it. Those of you who have followed this series carefully will have grasped the general idea that additional tuned stages mean improved selectivity, while additional amplification means greater sensitivity.

There can be no denying that this assumption is perfectly correct and it would seem a logical approach to the problem. As a matter of fact, for many years this was the only approach, and engineers battled with the problem of designing a set which would have sufficient sensitivity and selectivity—particularly the latter—to be classed as suitable for any location no matter how difficult.

Thus they progressed from a single tuned stage to two tuned stages, with an additional valve as an RF amplifier, then three stages, with yet another valve, and in some cases to a fourth stage as a preselector, but without an additional valve. At first, each of these tuned stages had its own dial and tuning in a station was a major undertaking. Later the advent of "ganged" condensers made possible a single tuning control.

SELECTIVITY

You may imagine that such an array of tuned circuits would provide sufficient selectivity, while the additional amplification would give sufficient sensitivity. If it didn't,

it would at least be only a matter of providing additional stages until the desired effect was obtained.

Well, the fact was that results were better, but still not really good enough. However, it was not practicable to keep tacking on extra stages "ad infinitum"—two RF amplifier valves being about the limit.

How come?

Mainly because of instability, or the tendency for signals to feed back from a point of high level (after amplification) to a point of low level (such as the input to a preceding stage). This is exactly the same process as that used to provide regeneration in our simple sets, but there is a vast difference between controlled regeneration and the hopeless feedback which occurs when there is too much interstage coupling in a high gain set.

There are a number of causes of this coupling, the main ones being stray capacitance between wires and the use of a common power supply.

For a given set of conditions the tendency to feedback increases with frequency and with the gain of the set so that, in most cases, the gain had to be deliberately restricted in order to maintain stability. To make matters worse the gain of the set would vary considerably, being much greater at the high frequency end than at the low, due to the greater efficiency of the coils at the higher frequencies.

by Philip
Watson

This meant that the set had the greatest gain where the tendency to feedback was greatest and, by the time it had been made stable at the high frequency end, the sensitivity at the low frequency end was extremely poor.

From all this you can see that the tuned radio frequency (TRF) set, while a logical development, had a lot of disadvantages and it is little wonder that engineers were enthusiastic at the prospect of a circuit which would overcome all these disadvantages at one fell swoop.

THE SUPERHETERODYNE

This circuit was the superheterodyne and I think it can fairly be said that, apart from a few teething troubles, it fulfilled its promise. As a result there are very few commercial sets today which do not employ it.

While it is not difficult to understand the general principle, there are quite a number of new ideas to grasp and we have decided to devote this month's article entirely to a discussion of the superheterodyne. Next month we will be back on the building side again with a simple, but very effective design for this type of set.

When we were discussing the TRF we pointed out that the gain varied with frequency and that instability was a major problem, particularly at the high frequency end. In the superheterodyne we overcome these problems by changing the frequency of the incoming signal to one which is easier to manage, usually much lower, and which is known as the "intermediate frequency" or IF.

With only one frequency to handle the amplifier may now be designed to give maximum performance at that frequency and, by making it a low one, we can safely make the gain high without the fear of instability. At the same time the tuned circuits may be designed for maximum selectivity, although a goodly contribution in this regard comes from the mere fact of changing frequency, as we shall see presently.

You will probably get a better idea of the process if we trace the progress of a typical incoming signal using a few simple figures which are typical of present practice. Have a look at our block diagram.

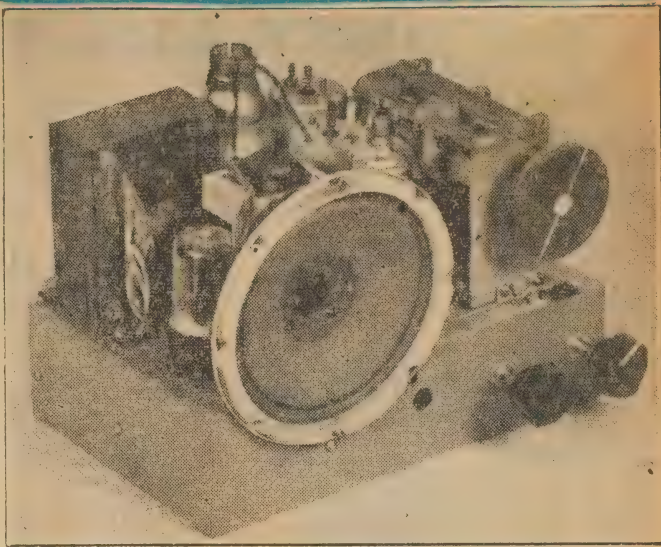
SIGNAL TRACING

The incoming signal at, say, 1000 Kc is first applied to the primary of a standard aerial coil, the secondary of which is tuned by one section of a two-gang condenser. The selection at this stage is not very great, as you can appreciate, but a rough selection is necessary as we shall explain later.

From the first tuned circuit the signals are applied to the mixer valve to which is also applied the output from a local oscillator circuit. The frequency of this oscillator is controlled by the second section of the gang condenser and the associated circuitry is so arranged that it will always be higher than the incoming signal frequency by 455 Kc — the figure most frequently used nowadays for the intermediate frequency.

The job of the mixer valve, as its name implies, is to mix the incoming signal with the local oscillator signal to produce the new, or intermediate, frequency. This it does by making

TYPICAL SMALL SUPERHETERODYNE



This is the type of set we have in mind for you to build next month. Although larger than our previous designs it should not prove particularly difficult, and most of the parts you already possess can be used.

use of the principle of beat notes or "heterodyning."

BEAT FREQUENCIES

When two frequencies, whether radio or audio, are impressed on some device which is non-linear, that is, one which amplifies one half of the wave more than the other, there will be produced new frequencies equal to both the sum and difference of the two original frequencies.

The mixer is such a non-linear device (and for this reason is sometimes called the first detector), which in mixing the incoming signal at 1000 Kc with the local oscillator at 1455 Kc produces two new frequencies, one at 2455 Kc (the sum) and the other at 455 Kc (the difference). The latter is the one which interests us and it is selected from the unwanted signals by feeding the output from the mixer valve into a tuned circuit adjusted to 455 Kc.

This is really the first part of our IF amplifier and the tuned circuit would be part of the first IF transformer. From now on we may provide as many stages of amplification as required, or as can be used without fear of instability. With modern coils and valves one stage is usually sufficient and, in fact, about all that can be kept stable.

Following the IF amplifier we have a normal detector, audio amplifier and power output stage, which follow perfectly normal practice and may be as simple or elaborate as required.

So much, then, for the general idea. Now let's go back and deal with some of the individual sections in greater detail.

We mentioned that it was necessary to have some degree of tuning (pre-selection) ahead of the mixer and you may wonder why this is so if the IF channel is capable of the high degree of selectivity claimed.

Reverting to our original example, let us suppose that the local oscillator is set to 1455 Kc in order to produce a 455 Kc signal from the wanted 1000 Kc signal. Also assume that a station is transmitting on 1910 Kc. In the absence of any pre-selection this signal, along with all other unwanted signals, would be applied to the grid of the mixer valve.

MIXING

The wanted signal on 1000Kc would mix with the local oscillation and produce the necessary intermediate frequency. However, the signal on 1910 also differs from the local oscillator by 455Kc and it, too, will be changed to the intermediate frequency and will be heard as strongly as the wanted signal. This is known as "image" reception and is always removed from the wanted signal by twice the intermediate frequency.

In the case of a 455Kc IF the image will be 910Kc away from the wanted signal and it does not call for a great deal of selectivity ahead of the mixer to suppress unwanted signals with this frequency difference.

If a lower IF is used, as for example 175Kc which was popular in the early days of superhets, the difference will not be so great, in this case only 350Kc. A single tuned stage is not adequate in these circumstances and sets using such low intermediate frequencies invariably require an RF amplifier stage, making two tuned circuits, ahead of the mixer. A three-gang condenser is then required to accommodate the extra tuned circuit.

As well as receiving two stations at one spot on the dial, the "image" problem also makes it possible to receive the same station at two spots on the dial—an effect known as



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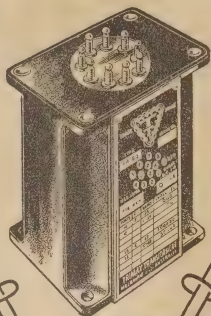
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still only removed from the wanted signal by 20Kc this is a greater percentage difference from 455 than it is from 1000, and a circuit tuned to 455 will have greater ease in rejecting it than one tuned to 1000. Furthermore, the IF selectivity due to this effect will be constant irrespective of the frequency of the incoming signal.

Carrying this idea to its logical conclusion it would seem possible to improve the selectivity still further simply by using lower values of IF and this is, in fact, the case. A 175Kc IF will have much greater selectivity than the 455Kc and, for special applications, such as communication receivers, even lower values in the order of 110 and even 50Kc are used to provide extremely high degrees of selectivity.

DOUBLE SUPERHETS

However, as already pointed out, the use of such values creates a very real problem in the matter of image reception and values less than 175Kc are usually reserved for "double superhet." circuits where the image has already been rejected by other means.

Such extreme selectivity, while invaluable in communication receivers, is not necessary in an ordinary broadcast set and can be a real disadvantage rather than an asset. This is due to what is called "side-band cutting" or the rejection of part of the wanted signal due to selectivity.

The part of the signal rejected always represents the higher audio frequencies so that excessive selectivity can cause the same effect as severe tone control action and, if carried to extremes, will even cause speech to become unintelligible. In lesser degrees it merely causes suppression of the higher musical frequencies, an effect which is very distasteful to the musically-minded listener, though it may be tolerated by the less discriminating.

This is another reason for the adoption of the 455Kc IF for domestic receivers, as it was found that the selectivity provided by the 175Kc system was excessive. Even the value of 455 is not free from this disadvantage, which is why many enthusiasts still prefer the TRF. However, it appears to be the best compromise of all the conflicting factors, such as simplicity of circuitry, ability to work in almost any location, and reasonable reproduction.

MORE COMPLEX

Considering all the things which happen to the signal from the time it arrives at the aerial until it finishes up in the loudspeaker, you may well say, "This idea of a superheterodyne is all very well, but how much greater will be the circuit complexity and how many more valves will I need to perform the various functions?"

Surprisingly enough you will only need one more valve, and the circuit will be little more complex than those you have already made, certainly not so great as to cause you any misgivings if you have successfully negotiated the Reinartz and Reflex circuits. Furthermore all the major components which you already have can be used, such as the chassis, two-gang condenser, power transformer, speaker, valves, &c., and not a very great outlay will be required for the changeover.

To give you some idea of how this is done we have taken a typical

superhet. circuit of the size we intend to use, and "exploded" it so that the individual sections may be picked out.

First we have the aerial, coil and one section of the gang forming the input circuit. This is shown in section A and is so straightforward as not to require comment.

Section B is the local oscillator circuit and consists of a coil and the other section of the gang condenser, shown in the lower part of the section, together with a triode valve section consisting of the cathode and the first two electrodes of the converter valve. You will notice that the "F" connection of the coil goes to a condenser marked PC and this is the padding condenser to keep the oscillator circuit correctly tracked.

A little examination of the circuit will show that it is similar to the regenerative circuit already described for the Reinartz Two. The upper electrode in this section of the valve can be regarded as the plate and is fed from the HT supply through the feedback winding shown between P and B.

This is inductively coupled to the grid winding (G and F), which is tuned to provide the required oscillator frequency and is coupled to the grid through a small condenser. The DC circuit of the grid is completed through the .05 megohm resistor, which also generates the necessary bias, using the grid current which flows at each positive cycle of the oscillation.

MIXER STAGE

Section C is the mixer and simply comprises the remainder of the valve consisting of a signal grid, into which the incoming signals are fed, and a screen and plate. With the cathode which is common to both sections this forms a more or less normal screen grid section.

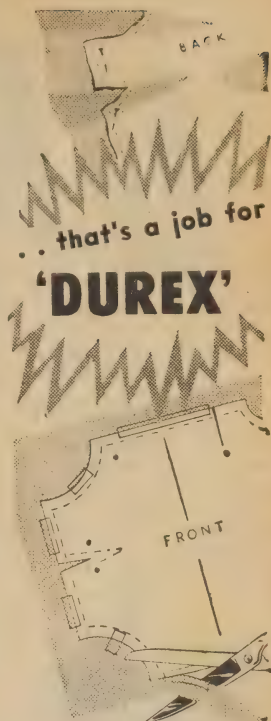
Section D is the IF amplifier channel and consists of an IF transformer coupling the mixer to the IF amplifier valve, the valve itself, and a second transformer coupling to the detector.

Most interesting component is the valve which, in addition to acting as an amplifier, has two diode plates which may be used for detection.

The detector circuit is built around these diode plates and the load resistor (.5 megohm) which is between the F terminal of the second transformer and the cathode of the IF amplifier valve. It is across this resistor that the audio signals are developed and they are picked off at the point F where it joins the transformer winding.

From here the signals go to the grid of the output valve, via a coupling condenser. This is a new approach for our audio systems, which up till now have had an amplifier stage as well as the power output stage. In larger sets this is still normal practice, but where we want the simplest possible receiver it is possible to dispense with this stage because of the higher gain ahead of the detector.

The foregoing should give you a fair idea of the job to be tackled next month. The essentials of the circuit will be the same, but minor modifications will be necessary to enable you to use the components you already have on hand. The finished job will be far and away better than anything described in this series to date and will hold its own against commercial sets of a similar number of valves.

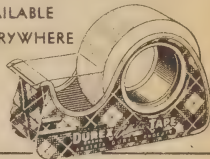


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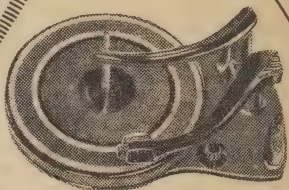
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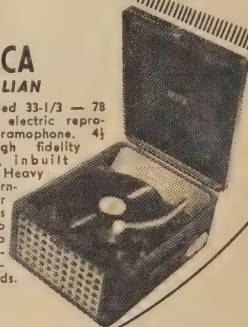
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PERFORMANCE DATA ON ACOS GP20

Following numerous requests for information on microgroove pickups, we have conducted initially a series of tests on the Acos GP20, which is currently one of the most popular types. Its performance is analysed and circuits suggested which are likely to yield improved results.

THE GP 20 is a crystal pickup and, as such, exhibits the familiar characteristics of high output voltage and a naturally rising bass response, which compensates in part for the normal recording loss. It can thus be used directly with ordinary receivers and amplifiers, without the need for preliminary amplification and tone correction.

It appears to be excellent mechanically and plays either standard or microgroove records without noticeable wear. Taken together, these characteristics readily explain its present popularity. But what of its electrical performance and compensation requirements?

THE HEADS

The GP20 has interchangeable heads for standard and microgroove recordings, the immediate point of difference being that the former carries a metal fairing to increase downward pressure on the needle point. In other respects, the heads appear to be identical, the styli being ground to the requisite dimensions and attached to the end of a cantilever arm.

This method of mounting lends compliance to the system and, combined with light weight, ensures low record wear.

The first test was aimed at discovering the output voltage, the frequency response and the overall consistency of the heads, when fed into the usual 0.5 meg. load.

For the 78 rpm tests, the record used was the HMV disc ED1189, and curves were run on a half-dozen individual heads taken at random from the distributor's stocks. The output from the pickup was fed into a 0.5 meg. load, thence through a level amplifier stage to an accurately calibrated vacuum-tube voltmeter.

INITIAL TEST

Pickup output from the 1000-cycle test groove varied from 370 to 800 millivolts, taking the extreme cases, either figure being nevertheless ample to drive an ordinary amplifier to full output. With typical recordings, the output on musical peaks is much higher, of course, rising on loud passages to something like four times the figure registered for the 1000-cycle test groove.

Averaged for all the heads tested, the output was 640 millivolts, indicating a likely figure of between 2 and 3 volts on peaks of heavily recorded music.

The next step was to ascertain the frequency response of the individual heads and the degree of consistency from one to the other. The matter of consistency is most important where any attempt at equalisation is anticipated.

Accordingly, the output was measured from each of the sample heads at test frequencies up to 14 Kc. The voltage figures were then converted to decibels, considering the output

by *W. N.
Williams*

from each head at 1000 cps as the reference level (or zero db.).

In figure 1, the curves of all six heads have been superimposed, and it is immediately apparent that their behavior is fairly consistent up to about 8 Kc. Beyond that, notable

variations do occur, but these will not prejudice the effect of equalisation in the lower and middle registers.

Note that the curves have been drawn with a deliberately open "db" scale to facilitate comparison. Due note must be taken of this when comparison is made with other curves which may be drawn with 10 db between major divisions.

The heavy curve in figure 1 shows the response average from the six heads. It represents the actual output from the cartridge and includes both the bass cut in the disc and the naturally rising bass characteristic of the pickup itself.

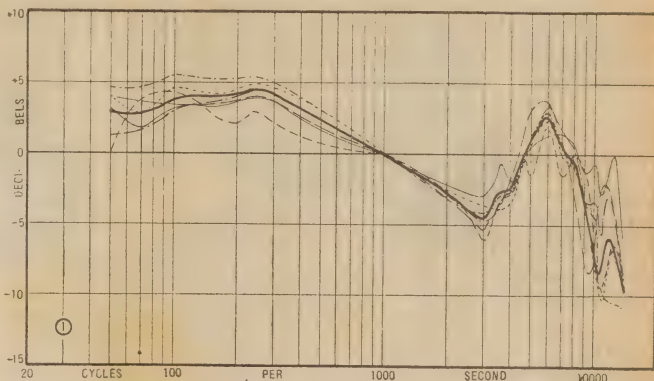


Figure 1.—The actual output obtained from six GP 20 heads from a test record cut to the standard British characteristic. Heavy curve represents the average response.

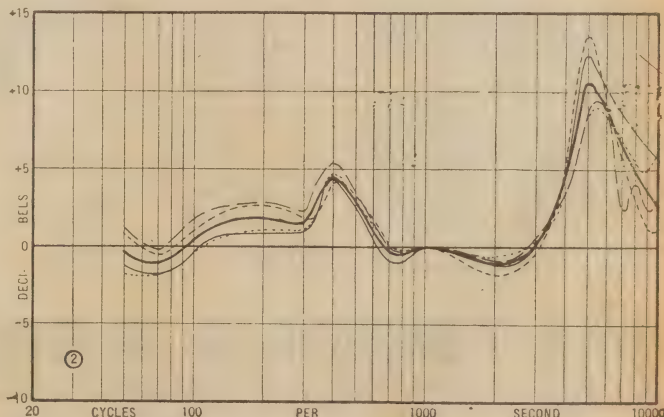


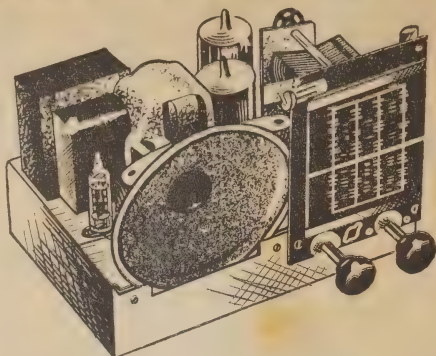
Figure 2.—Actual output from four GP 20 LP heads from a 33 rpm pre-emphasised microgroove test record. The need for de-emphasis is evident, if only with an ordinary tone control.

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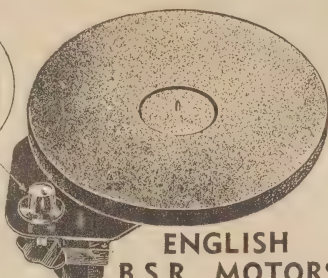


3 SPEED

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45 R.P.M.

33 R.P.M.



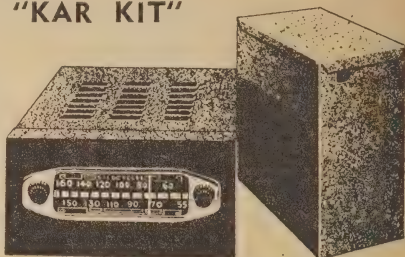
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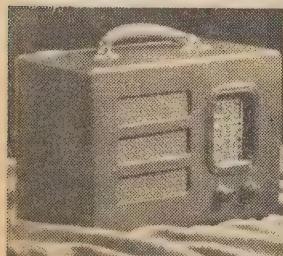
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Since the test record ED1189 is cut to the British standard characteristic, the heavy curve in figure 1 represents the actual frequency law, which can be expected with a British (or Australian) disc and a GP20 cartridge feeding into a 0.5 meg. load.

It will be seen that the bass is somewhat accentuated, particularly in the 200-300 cycle region, while the tendency to flatten at 50 cps indicates an approach to the arm resonance at about 40 cps. There is a trough at 3000 cps, a major peak at 6000 cps and a further peak at about 12,000 cps.

On American pressings, the overall response in the bass region would be more nearly level, because of the higher turnover employed, but the treble response would remain substantially the same.

Figure 2 shows the results of a similar series of tests carried out with a microgroove frequency disc and a number of microgroove heads, feeding into the same 0.5 meg. load.

The frequency disc has a bass roll-off from about 700 cps, reaching minus 18 db. at 50 cps. The treble shows a gradually rising response from 1000 cps upwards, being boosted some 12 db at 10,000 cps. This is typical of current microgroove recording characteristics, so that the curves of figure 2 show what can be expected from the GP.20.LP heads, playing a microgroove disc and feeding, without compensation, into a 0.5 meg. potentiometer.

Once again, the heads are reason-

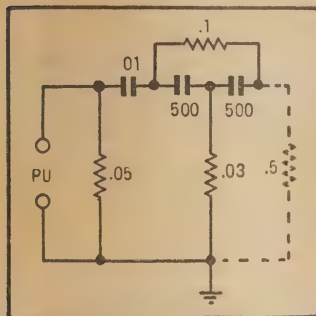


Figure 7: Suggested pad for feeding GP 20 LP or 78 heads into channel compensated for magnetic pickups. Constants provide some rejection in the 5-6Kc region.

ably consistent and the heavy "average" curve can be accepted as typical.

Apart from an apparent resonance effect at 400 cps, the response up to at least 1000 cps can be reckoned as level for most practical purposes. Beyond that, there is operating an obvious combination of the pre-emphasised recording characteristic and the same kind of treble response as was evident in the standard 78 head.

In fact, if the pre-emphasis characteristic is subtracted from the solid curve of figure 2, the result is very similar to figure 1. The peak is at 5000 rather than 6000 cps, and is somewhat sharper, but that is all.

It is obvious, however, that some form of treble compression must be used when playing microgroove, even if it amounts to nothing more than turning the tone control in the amplifier to the "mellow" position. This

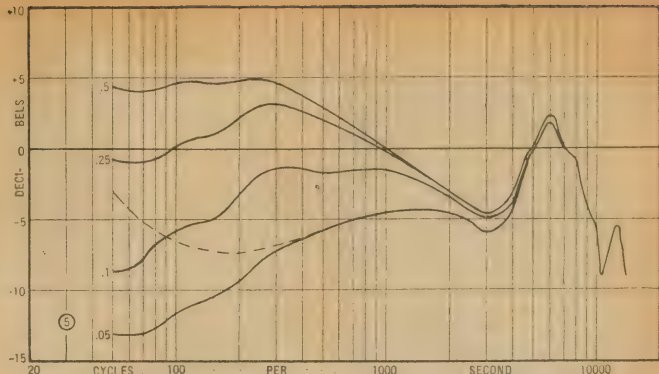


Figure 6: The effect of load on the actual output from a standard GP 20 head. Dotted curve shows the result of adding normal bass boost to the .05 meg. line

will have the effect of countering the treble pre-emphasis and produce a final result somewhat similar to that from standard recordings, when played without the tone control.

The output from the 1000-cycle test groove varied with these heads from 235 to 320 millivolts with an average of 260 millivolts. A comparative test on the oscilloscope indicated that the output to be expected on typical music peaks approximates 1.5 volt.

To correct the inequalities revealed by figures 1 and 2, the manufacturers have suggested two simple equalising circuits for the GP20 standard and LP heads.

The circuit for the 78 head (figure 5a), allows the pickup to operate at the lowest frequencies with the normal 0.5 meg. volume control, as its terminating load. Above about 100 cps, however, the reactance of the .005 mfd condenser drops sharply and the net load reduces ultimately to something less than 0.1 meg.

The resulting load curve counters the output rise shown in figure 1 at 250 cps and produces the results indicated in figure 3. The curves were taken with a head which was selected to coincide as closely as possible with the "average" curve of figure 1.

Curve A shows the actual frequency law imparted to the pickup,

while B is the response required for complete compensation of a typical British recording. Curve C is the actual output from the pickup and it seen to lie close to the reference line up to about 4Kc. Output peaks are still evident at 6 and 13 Kc.

Inclusion of the filter reduces the average nominal output from 640 to 470 millivolts but this is still adequate to drive most standard amplifiers to full output.

In view of the above, it would seem obviously desirable to employ the simple filter of figure 5a, wherever the standard 78 head is used to feed into a flat amplifier.

MICROGROOVES

For playing microgroove records a different network is required, which leaves the bass substantially untouched but reduces the treble response. The required effect is produced by the simple filter shown in figure 5b and the resulting overall response curve of record and pickup is shown in figure 4. Although the trough and peak effect is still apparent, the curve is more favorably located in relation to the reference line, rendering use of the tone control unnecessary as a means of de-emphasis.

The dotted curve B is included as a matter of interest and represents

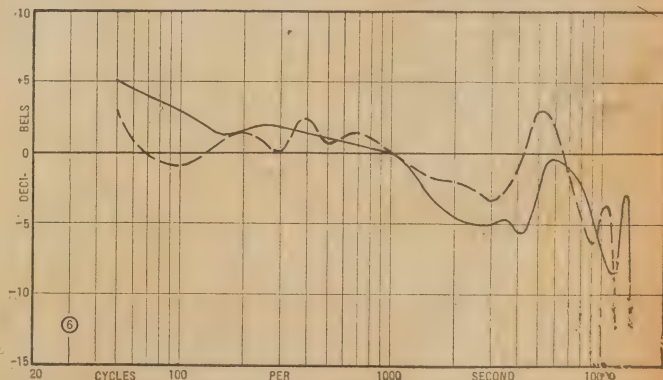


Figure 8: Actual pickup response measured through pad of figure 7, and corrected for recording characteristics. Solid line is 78 curve, dashed line LP. Vertical scale is still 5db per division.

the approximate correction which should operate when playing micro-groove records.

If the GP 20 pickup is used only for 78 or only for LP records, the compensation required in each case can very easily be arranged by clipping the two relevant component permanently across the pickup terminals, along with the pickup leads.

It is important to see that the pickup is switched ultimately across a 0.5 megohm load, because this will control the bass response. If the receiver or amplifier has a 1.0 megohm potentiometer for the pickup input circuit, the position can be rectified by connecting a 1.0 meg. resistor externally across the pickup terminals, in addition to the equalising network. If, on the other hand the effective initial load is lower than 0.5 meg., a higher value potentiometer will have to be installed to avoid loss of bass.

Figure 5c shows a combination of (a) and (b) with a two-way switch to select the appropriate equalisation for 78 or LP records, according to the type being played. The switch could well be mounted on the motor board alongside the pickup base.

The foregoing curves indicate the desirability of including this equalising network as a matter of course, wherever the GP 20 is fed into a standard receiver or amplifier. Results will generally be much better than if the pickup is simply fed into an uncompensated 0.5 meg load.

LOW-LEVEL STAGE

In special cases it may be desired to feed a crystal pickup into a low-level compensating stage, such as the "Playmaster" control head described last month. When this is done, it is common practice to reduce the load across the pickup in order to limit its output and the natural rise in bass response.

Figure 6 shows the actual output of the "average" head from the British test record with various values of load. A 0.25 meg. load leaves the bass substantially level but a reduction of the load to 0.5 meg. produces a tapering off in the bass register which is roughly parallel to the recording characteristic. Adding the bass compensation provided by the Playmaster or similar units restores the bass as indicated by the dotted curve.

The output from the 1000-cycle test groove proved to be 470 millivolts under these conditions, so that the peak output might conceivably overload some low-level compensating stages. This would necessitate

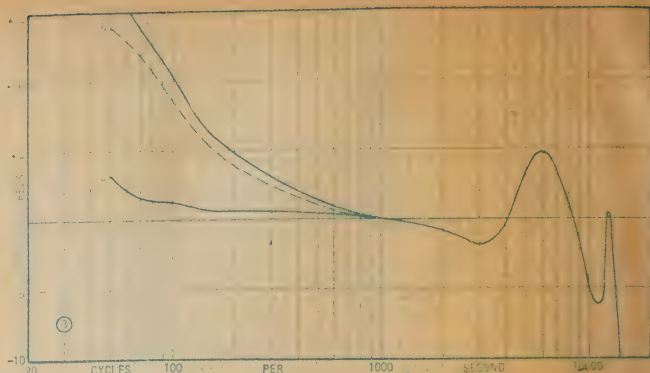


Figure 3.— Curve A is the compensated response of the pickup, B the required bass compensation and C the actual pickup output. It is within 2 db limits between 60 and 4500cps.

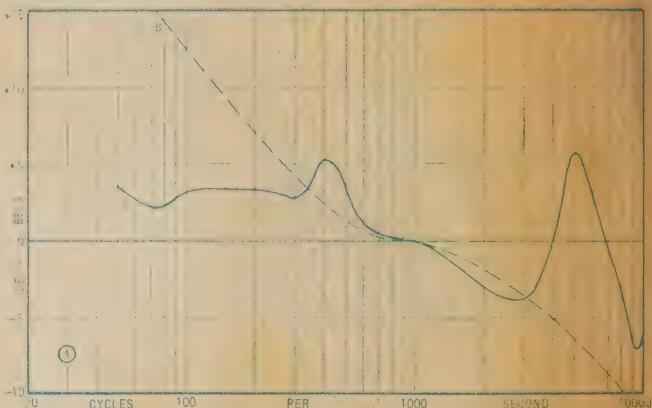


Figure 4.—Using the compensation of figure 5b, the actual output from the microgroove head from a pre-emphasised disc as shown as curve C. Curve B shows the approximate compensation required.

using two resistors for the load which would add up .05 meg. but reduce the input to the preamplifier by a factor of two or three times.

An obvious and convenient choice would be to connect a 35,000 and a 15,000 ohm resistor in series across the pickup output, with the 15,000 ohm resistor returning to earth. The signal for the amplifier grid would be taken from the junction point and would approximate 140 millivolts under nominal test conditions. This would be slightly higher than one

would expect from an average light-weight magnetic pickup.

As revealed by curve 5, the most serious objection to operating the pickup in this fashion is that it leaves the natural treble resonance peak almost entirely above the effective reference line and to the tune of some 6 or 7 db.

Just how serious this is likely to be depends in turn on the overall characteristics of the associated amplifier and speaker—particularly the latter. If it has a sharp down-

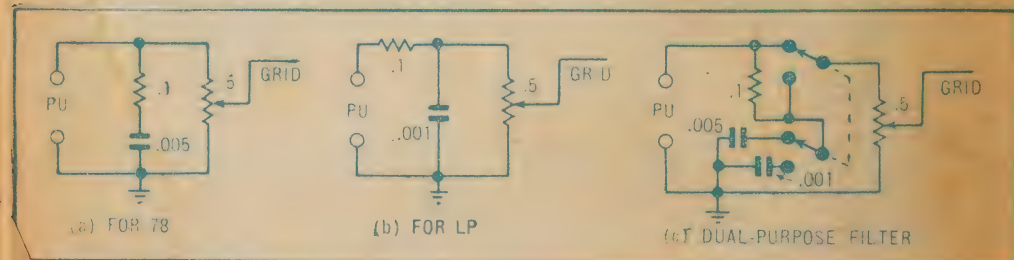


Figure 5: Compensation circuits suggested by the manufacturer's (a) for 78 heads and (b) for LP heads. The circuits could be combined as in (c) and a two-way switch used for 78/LP selection.

ward taper after 4Kc, as many speakers have, the effect of the peak would largely be to add an unaccounted degree of brightness to the reproduction.

With a wide-range amplifier and speaker, however, the peak would be made obvious by its likely accentuation of scratch and distortion on mediocre records and by its accentuation of sibilants on others.

One method of treatment would be to provide a resonant L/C absorption circuit tuned to 5 or 6 Kc, as has been done on previous occasions with magnetic pickups. Chief objections to this treatment are the difficulties of duplicating an original design without a means of checking results and the chance of picking up stray hum in the coil. Nevertheless we will probably be doing more work with tuned circuits in the near future and may be able to suggest suitable constants for those who may require them.

In the meantime, a somewhat similar result can be obtained more readily by feeding the pickup through a form of "m" pad which slightly reduces the amplitude of the peak and lowers it bodily with respect to the reference line.

The constants for such a pad are shown in figure 7 and, provided they are adhered to, there is no reason why the original results should not be duplicated.

With the pad in circuit, the overall response curve and output figures will be comparable with those of a lightweight magnetic pickup and the signal can be fed through the same amplifying and compensating channels, if required.

For simplicity, the same pad can be used with either the 78 or LP heads, so that no switching is required.

Figure 8 shows the response which may be expected in each case with the usual amount of bass boost operating provided by compensating circuits for magnetic pickups.

It will be seen that the response curve for the 78 head is slightly down, in the treble region, with respect to the response curve on microgroove. The difference is actually very slight in practice and is not without its good points in that few 78 records will stand completely level reproduction without their inherent distortion and scratch making its presence felt.

If the pickup is to be used on 78 rpm records only and it is desired to lift the top response to the zero line, the load resistor can be dropped from .05 meg. to about .035. As previously stated, this type of pad is only suitable where the pickup is to be fed into a fully compensated preamplifier stage.



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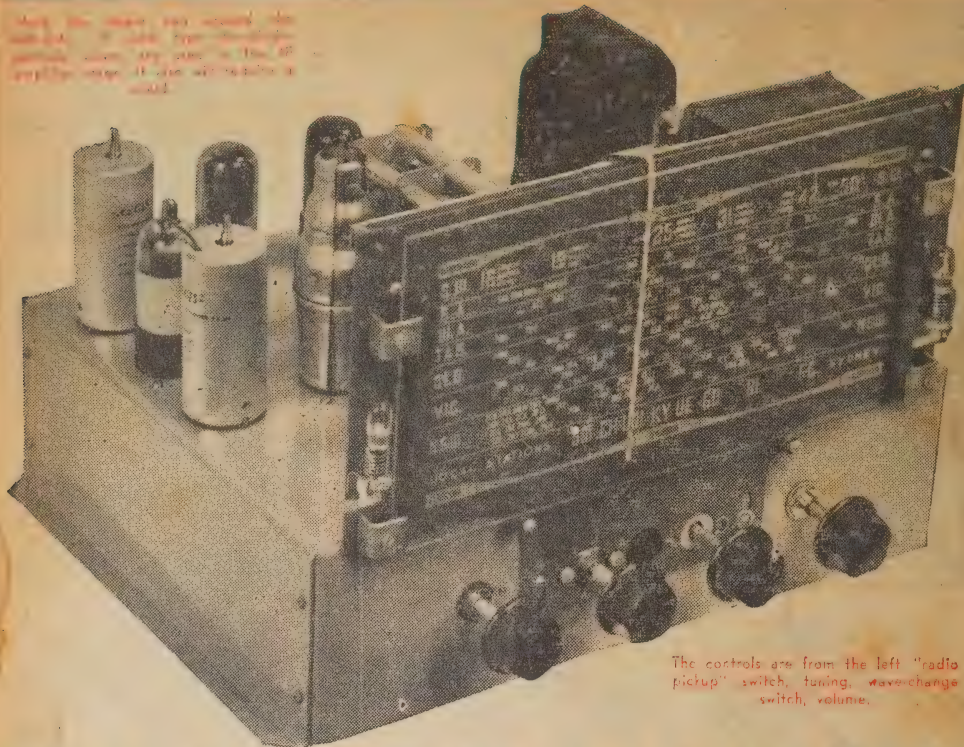
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1951 SUPER-SIX RADIOGRAM

Maintaining the tradition of the "Super Six" series, this new version boasts high gain and selectivity. It is therefore the natural choice for the country listener or for anyone else interested in long distance reception. The pickup circuit allows it to be used, if necessary, with the new "Playmaster" control unit.

THE performance of the tuning section is boosted by the use of an RF stage, while the audio system will do as well, if not better, than commercial radiogram units.

In the matter of layout, we have made a determined—and successful—attempt to solve the vexed question of coil unit mounting.

For various reasons, the dual-wave oil units which provide for an RF stage, have come in various shapes and sizes with no attempt to standardise the positions of cores, trimmers and connections.

Most of the more ambitious receivers in the past have therefore had to be designed around one particular unit to the exclusion of others, with the result that difficulties arose when readers wanted to use their old brand or a unit they happened to have on hand.

This time, we spent many hours with ruler and pencil, jockeying dimensions back and forth, dodging

the dial mechanism, balancing the knobs, getting the adjustments in the clear and planning where the leads would go with each unit.

The result of our labors is that your new chassis will take any one of the three or four popular coil units and you can therefore select the one which best satisfies your eye and your pocket. In fact, with a little mechanical contrivance, you could easily instal separate coils for either a straight broadcast or for your own switched dual-wave version.

We anticipate that this chassis will ultimately supersede the older chassis intended for the same kind of receiver.

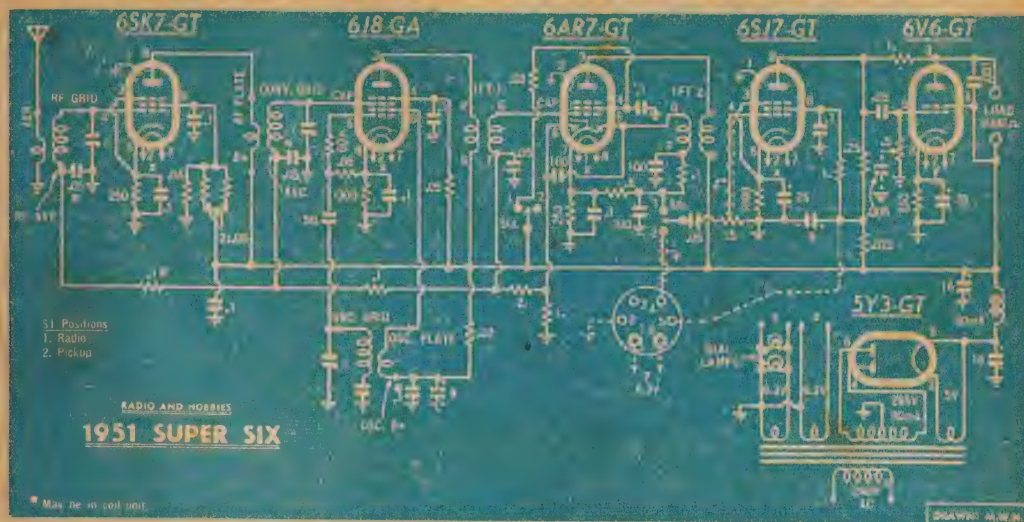
The provision for interchangeable tuning units, the use of large valves and standard-sized components should assist in getting together a complete kit, thus avoiding some of the "shopping" difficulties which seem the lot of a radio constructor at the moment.

CIRCUIT DETAILS

Treating the circuitry in detail, the screen of the 6SK7-GT RF amplifier is fed from a divider formed by three resistors connected in series-parallel across the high tension supply. This holds the screen at a near-constant potential to improve the AVC action on this stage. For the .03 megohm value in the divider from the high tension to the screen, two .06 megohm resistors were connected in parallel to give this value

by Raymond
Howe

CIRCUIT DIAGRAM OF THE 1951 SUPER-SIX



The arrows shown on the connections to the coils in the RF and converter stages are the connections which you will expect to locate on the coil unit. The 6-pin socket is for the pickup or pickup control head mentioned in the text. The 50 ohm resistor at the 6J8-GA oscillator grid is a safeguard against parasitic oscillation on the extreme short wave end of the range.

with a 2 watt dissipation rating. Although the dissipation will be about $\frac{1}{2}$ watt only, it is good practice to expend this over two 1 watt resistors.

The use of cathode bias is rendered necessary for reasons soon to be given.

In the particular coil unit used in our prototype set, decoupling components were wired within the unit itself in the high tension feed to the plate winding of the RF stage. They are a 5000 ohm resistor and a .1 mfd capacitor. The set is stable without these components in circuit, but no doubt, the manufacturer considered them a worthwhile safeguard.

Again, in this particular coil unit, the AVC components are wired in the unit, as purchased. These will be the .1 megohm between the RF and converter grid coil windings and the .1 mfd capacitors at each end of the resistor. Whether the unit which you purchase has these components in can easily be seen by inspection aided by the code or chart of the coil unit connections. If they are not already included you must add them externally according to the circuit.

CONVENTIONAL DESIGN

In the converter stage, we used the 6J8-GA valve. It has adequate this set. Any higher gain in this direction may prove a little embarrassing or at least, render the wiring layout of the "front end" more critical.

The wiring of this stage is quite conventional. AVC is used on this stage on the broadcast band only. This is usual practice and the wiring of the unit is such that the earthy end of the converter grid coil is removed from the AVC line and earthed

when the wave-change is set to the "short-wave" position.

This is actually the reason why cathode biasing is necessary on the RF converter and IF stages. The biasing of these stages via the AVC line is simpler, requiring only one resistor in the power transformer centre-tap return to give the "back-bias," but this would leave the converter without bias when on the short-wave.

This method thus being ruled out, it means that the first three stages

must be cathode-biased if we want to provide them with AVC.

Another important point in this stage is the value of the oscillator grid coupling capacitor. Do not go over the 50 pf value shown in the circuit if you want to avoid a form of "squegging" at the high frequency end of the shortwave band. This may not be so in every case, but there is a tendency to instability with this valve.

Unlike the RF and IF valves, the 6J8-GA has no internal or external

PARTS LIST

- 1 Chassis 13in x 10 $\frac{1}{2}$ in x 3 $\frac{1}{2}$ in.
- 1 Power transformer 285 Volts per side, 80 mA, 6.3V 2A, 6.3V 2A, 5V 2A.
- 1 80 mA filter choke.
- 1 Dual-wave coil unit with RF stage (to suit 6J8-GA or 6J8-G).
- 1 3-section tuning gang (AWA or Stromberg H).
- 1 Dial to suit coil unit and gang.
- 2 Standard 455 kc IF transformers, Nos. 1 and 2.
- 6 Octal sockets, 1 6-pin and 1 4-pin socket.
- 1 2-pole 2-position wafer or rotary toggle switch.
- 1 Valve shield.

VALVES

- 1 6J8-GA, 1 6SK7-GT, 1 6AR7-GT, 1 6SJ7-GT, 1 6V6-GT, 1 5Y3-GT.

CAPACITORS

- 3 25 mfd 40 PV electrolytics, 2 16 mfd and 1 8 mfd 525 PV electros, 5 .1 mfd 400 WV (1 may be in coil unit), 3 .1 mfd 200 WV, 5 .05 mfd (two may be in unit—those on AVC may be 200 WV), 1 .001 mfd, 3 100 pf mica, 1 50 pf mica.

RESISTORS

- 1 2 meg, 3 1 meg, 2 .5 meg, 1 .5 meg potentiometer, 1 .25 meg, 3 .1 meg (one may be in unit), 1 .08 meg (two .04 meg in series), 2 .06 meg, 2 .05 meg, 1 .04 meg, 1 .02 meg, 1 .025 meg, 1 1000 ohms, 1 300 ohms, 2 250 ohms, 1 250 ohms 3 watt ww.

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- 4 knobs, 2 dial lamps, 2 terminals (1 red, 1 black), 1 shaft coupling or shaft extension, 3 1 inch threaded mounting-pillars, 2 5-tag and 1 3-tag mounting strips, 2 $\frac{1}{2}$ in and 2 $\frac{3}{4}$ in rubber grommet, approx. 2 feet of PTIM shielded cable and shielded hook-up wire, power flex and plug, tinned copper wire, hook-up wire, nuts, bolts, solder, lugs, &c.

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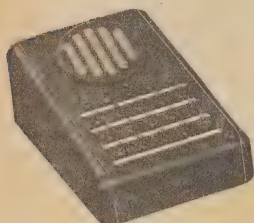
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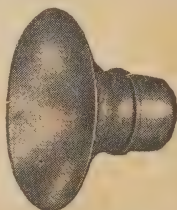
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shield as part of the valve structure. Consequently, a shield was fitted over this valve to avoid any possibility of unwanted direct coupling with other components on the chassis top. This shield is earthed via a small spring strip which fits over pin 1 of the valve base. Of course, pin 1 of the socket must be wired to chassis.

There is an 8 mfd 525PV electrolytic shown dotted in the circuit diagram in the position of high tension feed to the oscillator coil feedback winding. This is required only if there is evidence of a form of "motor-boating" when tuning to the high frequency end of the short-wave band. This condition is known as "oscillator flutter" and is caused by low frequency coupling via the high tension line to other portions of the "front-end" circuit.

OTHER TYPES

We had a reason for using the 6AR7-GT valve in the position of IF amplifier, audio detector and AVC. In the first place, it is a "GT" type. Secondly, the pentode portion has a mutual transconductance of about 2500 microamps, giving a little more "lift" in the IF channel than the older types and yet not introducing any problems which can crop up with higher gain miniature types.

Of course, the 6G8-G type could be used simply by changing the socket wiring. It would also be necessary to change the value of the screen resistor to .06 megohm for 125-volt screen operation or .1 megohm for 100-volt screen operation. Naturally the former condition gives slightly higher gain for an extra 3-odd milliamperes of current drain.

We wanted the detector and AVC diode anodes to be contained in the IF amplifier so as to keep the audio end entirely separate from the rest. Hence the selection of a duo-diode-pentode for the IF amplifier socket.

Having two separate diode anodes to play with, we used delayed AVC. This is obtained simply by returning the earthy end of the AVC diode anode load resistor to chassis rather than the cathode of the 6AR7-GT. Obviously, we do not want this "delay" voltage effective in the detector diode circuit and so the .5 megohm load resistor is returned to the cathode of this valve, rather than to chassis.

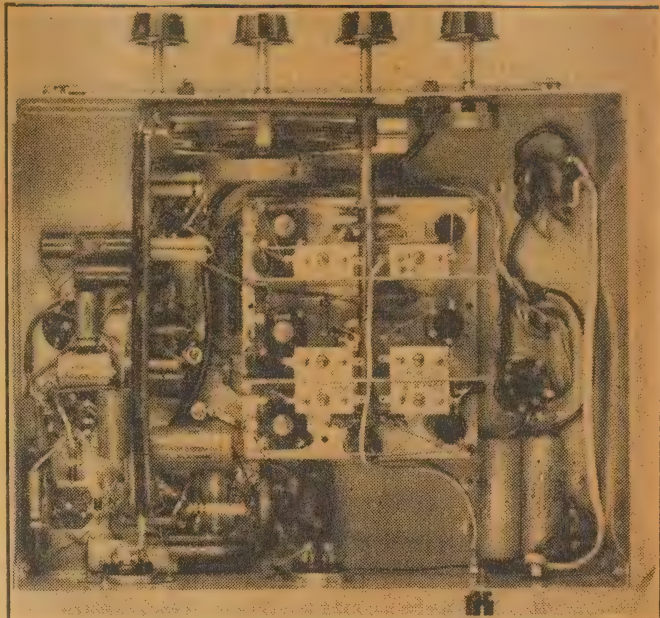
The AVC diode anode in the 6AR7 is coupled to a source of RF via the 100 pf capacitor to the detector diode anode. It does not matter much whether it couples to this point or to the plate of the 6AR7-GT, the choice being more or less dictated by wiring ease. We chose the other diode anode as it simply meant bridging the capacitor from one diode pin to the other on the valve socket. Incidentally, it doesn't matter which diode anode is employed for detection in the case of these indirectly heated valves.

RF FILTER

An RF filter is shown in the circuit between the lower end of the diode winding on the second IF transformer and the detector load resistor. Here is another stability safeguard. It is not always necessary but it is good insurance. It consists of the .1 megohm resistor and the second 100 pf capacitor.

Here at the "top" end of the diode load resistor is the wiring to the "pickup" switch which switches either the diode load or the pickup

SUPER-SIX UNDERCHASSIS VIEW



The general wiring layout can be seen from this photograph. The socket at the centre rear is for the speaker, that on the left for the pickup or pickup control head. The shielded wiring from the switch to this socket is supplied by the connections.

to the volume control feeding the grid of the 6SJ7-GT first audio valve. Incorporated with this switching is the control of the voltage feed to the screen of the IF amplifier. In the "pickup" position of this switch, the screen voltage of this stage is removed to avoid any "play-through" of radio programs when using the pickup.

Only one of the available dual-wave coil units has sufficient positions and spare contacts on the wave-change switch to permit this pick-up switching without installing the separate switch. You can see by visual inspection of a coil unit whether there are any spare sections on the wave-change switch. Let this guide you on the decision of fitting the separate switch.

AUDIO DECOUPLING

In the case where the wave-change switch will do the job the position on the chassis occupied at present by the separate switch can be taken by a tone control. We have shown such a control dotted in the circuit diagram at the grid of the 6V6-GT. It will merely mean replacing the .5 megohm grid resistor of this valve with a .5 megohm potentiometer, the moving arm being connected via a capacitor to the earthed end.

The value shown for this capacitor is about optimum but you may like to vary the value one way or the other to suit your own idea as to the amount of treble cut necessary.

The plate and screen feed to the 6SJ7-GT stage is decoupled with a .025 megohm resistor and an 8 mfd electrolytic capacitor to prevent hum from the high tension line from being

introduced into the grid circuit of the 6V6-GT and thus being amplified.

There is little to the 6V6-GT output stage. It is operated with normal bias for class A operation, and under such conditions is capable of the nominal output of 4.5 watts into the primary winding of the speaker transformer. A certain amount of feedback is introduced over this stage by taking a resistor from the plate to the plate of the preceding stage. The value of this resistor has been selected to give "eight to 10 decibels" of feedback, an optimum amount under the circumstances.

The power supply takes the usual trend of a 285 volts a side transformer, a 5Y3-GT rectifier and a single section capacitor-input filter. The 80 mA is quite sufficient to take the drain of all valves without resort to over-bias in the audio. With this combination the output voltage from the filter is around the 260 volt mark, thus allowing the 6V6-GT to function under its normal 250 volt plate and screen to cathode rating.

LOW HUM LEVEL

With the 16 mfd electrolytic filter capacitor the hum level is quite low. If you have reason to be a little more critical on this matter you could substitute 24 mfd electrolytics for the 16 mfd ones fore and aft of the filter choke. It is assumed, of course that you will use a filter choke of reasonable quality, that is, one which maintains something near its rated value of inductance when just on 80 mA are flowing through it.

The electrical design of this set presents no difficulties because accepted practices over the years

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PF 126 240	12 250 60	12.6V CT @ 1A		71/11
PF 146 200,30,40	12 325 150	12.6V CT @ 2.5A		120/9

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		Res.		
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CF 103	30	420	60	48/2
CF 104	30	580	75	43/1
CF 105	15	250	80	20
CF 106	12	200	100	59/2
CF 107	30	350	100	61/7
CF 108	12	135	150	64/3
CF 109	20	225	150	74/8
CF 110	12	100	200	74/8
CF 111	16	165	200	74/8
CF 112	10	70	250	74/8

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CF 113	5	70	250	Swinging choke	82/-
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OP51	4500 PP	15.5, 12.5, 8.6, 2.7, 2	15	132/3
OP63	10000 PP	15, 3.75	15	174/6
OP64	10000 PP	12.5, 3.125	15	174/6
OP65	10000 PP	8.4, 2.1	15	174/6

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OP25/40	10000 PP	40, 10	15	183/4
OP25/16	10000 PP	16, 4	15	183/4
OP25/15	10000 PP	15, 3.75	15	183/4
OP25/12	10000 PP	12, 3	15	183/4
OP25/10	10000 PP	10, 2.5	15	183/4
OP25/8.4	10000 PP	8.4, 2.1	15	219/6
OP66	5000 PP	8.4, 3.7	15	219/6
OP67	5000 PP	15, 6.5	15	219/6

OUTPUT TRANSFORMER TO LINE— Full Freq. Range

OP22	3250 SE	500, 125, 2.3	10	112/3
OP19b	5000 PP	500, 250, 125	15	163/5
OP21	8000 PP	500, 250, 125	15	133/6
OP62	10000 PP	500, 125	15	174/6

OUTPUT TRANSFORMER TO LINE— Special Full Freq. Range

OP25/500	10000 PP	500, 125	15	183/4
OP25/250	10000 PP	250, 62.5	15	183/4

VIBRATOR TRANSFORMERS

Code No.	Pri. V.	D.C. M.A.	Full Sec.	
VT 100	32 200	40 .005	Sync.	50/9
VT 101	6 90	15 .008	"	39/11
VT 102	8 130	25 .005	"	46/6
VT 103	6 200	50 .005	"	49/-
VT 104	6 250	60 .005	"	50/2
VT 105	12 250	60 .005	"	51/11
VT 106	6 300	75 .008	"	82/10
VT 107	6 250	60 .005	Sync. Low Rad.	54/10
VT 108	12 90	15 .008	Sync.	41/5
VT 109	24 90	15 .008	"	43/9
VT 110	12 150	25 .005	"	49/-
VT 111	24 150	25 .005	"	53/8
VT 112	12 200	30 .005	"	51/4
VT 113	24 200	30 .005	"	51/4
VT 114	12 300	30 .005	"	51/4
VT 115	24 300	30 .005	"	89/3
VT 116	24 250	60 .005	"	90/3
VT 117	12 250	60 .005	Non Sync. Low Rad	57/2
VT 119	32 150	25 .005	Sync.	55/5
VT 121	6 180	30 .005	"	49/2
VT 122	6 400	50 .005	"	51/4
VT 123	12 320	125 .005	Sync.	83/10
VT 124	32 250	60 .005	"	107/10
VT 127	6 200	80 .005	Sync. Low Rad.	56/-
VT 128	12 250	60 .005	Sync. Low Rad.	51/4
				60/8

RECEIVER POWER TRANSFORMERS

Code No.	Prim.	HTV Aside	M.A.	Filaments	Retail
PF 1851	240	150	30 6.3V @ 2A		50/2
PF 106	240	325	45 6.3V @ 2A, 5V @ 2A		53/11
PF 198	240	285	50 6.3V @ 2A, 5V @ 2A		50/2
PF 151	200, 30, 40	285	60 6.3V @ 2A, 5V @ 2A		60/8
PF 165	200, 30, 40	385	60 6.3V @ 2A, 5V @ 2A		66/6
PF 170	200, 30, 40	285	80 6.3V @ 2A, 6.3V @ 2A, 5V @ 2A		72/2
PF 168	200, 30, 40	385	80 6.3V @ 2A, 6.3V @ 2A, 5V @ 2A		69/5
PF 130	200, 30, 40	285	100 6.3CT @ 2A, 6.3V @ 2A, 5V @ 2A		77/9
PF 160	200, 20, 40	385	100 6.3CT @ 2.5A, 6.3V @ 2A, 5V @ 2A		87/3
PF 152	200, 30, 40	285	125 6.3CT @ 3A, 6.3V @ 2A, 5V @ 2A		97/6
PF 181	200, 30, 40	385	125 6.3CT @ 3A, 6.3V @ 3A, 5V @ 2A		109/2
PF 174	200, 30, 40	285	150 6.3CT @ 2A, 6.3V @ 2A, 5V @ 2A		102/5
PF 175	200, 30, 40	385	150 6.3CT @ 2A, 6.3V @ 2A, 5V @ 3A		127/9
PF 173	200, 30, 40	425	175 6.3CT @ 3A, 6.3V @ 2A, 5V @ 3A		197/9
PF 140	200, 30, 40	385	200 6.3CT @ 3A, 6.3V @ 3A, 5V @ 3A		181/-
PF 171	200, 30, 40	385	250 6.3CT @ 4A, 6.3V @ 3A, 5V @ 3A		243/7
PF 201	240	225	50 6.3 @ 2A		51/1

LINE TO VOICE COIL TRANSFORMERS

	Pri. Imped.	Sec. Imped.	Watts	Retail
MT111	500	12.5, 8, 2.3	10	69/1
MT100	500	4, 3	10	64/2
MT101	500	15	15	64/2
MT124	600, 500	4, 3, 2.7, 2.3, 2	25	107/10
MT125	600, 500	15, 12.5, 8.4, 6.5	25	105/2

MODULATION TRANSFORMERS

MT118	8000, 6000 PP	10000, 7000 5000	25	169/4
MT119	8000, 6600, 3800 PP	10000, 7500, 6500 5500, 4500, 3500	50	195/1
MT120	500 to 20000 in steps.	500 to 30000 steps.	50	356/10
MT121	500 to 20000 in steps.	500 to 30000 steps.	125	444/-

Output Transformer To Voice Coil—P.A. Range

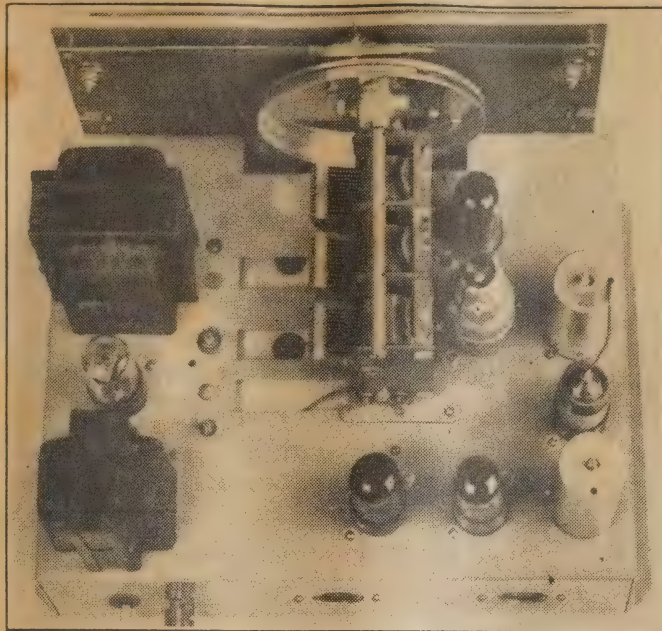
	Pri. Imped.	Sec. Imped.	Watts	Retail
OP1	5000, 2500 SE	12.5, 8, 2.3	10	71/3
OP54	5000, 2500 SE	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	10	82/3
OP39	5000, 2500 SE	15	10	72/6
OP43	5000, 2500 SE	5, 2.7	10	72/6
OP41	5500 SE	3.7	10	81/1
OP53	30000, 20000 14000, 10000, 7000 5000, 2500 SE	2.3	10	70/1
OP2	5000 PP	12.5, 8, 2.3	15	109/11
OP55	5000 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	15	120/5
OP3	6600 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	15	109/11
OP56	6600 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	15	120/5
OP4	10000 PP	12.5, 8, 2.3	15	109/11
OP57	10000 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	15	120/5
OP5	10000, 6600, 5000 PP	12.5, 8, 2.3	15	109/11
OP58	10000, 6600, 5000 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	15	121/11
OP59	10000, 6600, 5000 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	25	152/9
OP60	10000, 6600, 5000 PP	15, 12.5, 8.4, 6.5, 4, 3, 2.7, 2.3, 2	32	195/-

OUTPUT TRANSFORMER TO LINE—P.A. Range

	Pri. Imped.	Sec. Imped.	Watts	Retail
OP1A	5000, 2500 SE	500	10	71/3
OP44	5000, 2500 SE	500, 250, 125	10	84/8
OP34	5000 PP	600, 300, 200, 150, 130, 100 75, 50	15	131/-
OP6	5000 PP	500, 250, 125	15	109/11
OP7	6600 PP	500, 250, 125	15	109/11
OP8	8000 PP	600, 300, 125, 60, 30	15	228/4
OP9	10000 PP	500, 250, 125	15	109/11
OP8M	10000 PP	500, 250, 160, 125, 100, 83.5 71.5, 62.5, 55.5, 50	15	118/6
OP9	10000, 6600, 5000 PP	500, 250, 125	15	109/11
OP10	5000 PP	500, 250, 125	25	132/6
OP11	6600 PP	500, 250, 125	25	132/6
OP33	6600 P	600, 300, 250, 200, 170, 150 76, 50, 36, 27, 12.5, 7.5, 3.6, 2.7	25	228/4
OP12	10000 PP	500, 250, 125	25	132/6
OP13	10000, 6600, 5000 PP	500, 250, 125	25	132/6
OP35	10000, 6600 PP	500, 4000, 8.4, 2.2	25	187/4
OP14	5000 PP	500, 250, 125	32	161/-
OP48	6600 PP	140, 70	32	195/1
OP15	6600 PP	500, 250, 125	32	161/-
OP15M	6600 PP	500, 250, 166, 125, 100 83.5, 71.5, 62.5, 55.5, 50	32	162/6
OP16	10000 PP	500, 250, 125	32	161/-
OP17	10000, 6600, 5000 PP	500, 250, 125	32	161/-
OP36	3800 PP	17.6	60	171/-
OP18	3800 PP	500, 250, 125	60	173/4
OP61	3800 PP	100, 75, 50, 25, 10, 5, 3	80	223/-
OP37	6400 PP	500, 250, 125	105	236/3
OP49	8800, 6000 PP	500	105	355/10
OP20	11600, 8400 PP	500, 250, 166, 125	150	451/-

ALL PRICES SUBJECT TO ALTERATION WITHOUT NOTICE

LAYOUT OF THE 1951 SUPER-SIX



The 6SK7-GT is at the top right with the 6J8-GA behind and followed around the chassis by the 6AR7-GT, 6SJ7-GT and 6V6-GT in that order. The 5Y3-GT is at the left. Note that the dial drum is "floated" on the tuning gang spindle.

have settled most points in component design. A good many of the important design angles lie in the chassis layout:

In common with all of our designs we strive to arrange the circuitry and the chassis layout to suit most brands of available components which have similar electrical functions but differing physical characteristics. This is not always easy and sometimes it becomes necessary to compromise here and there.

In this layout everything more or less hinges around the coil unit. Their arrangement differs quite radically, a good layout for one will not necessarily suit another. A good deal of thought went into this problem and we feel that the resulting chassis layout will suit all available coil units rather well. The chassis blueprint will show the holes and cutouts so that any of the units can be mounted.

FREQUENCY COVERAGE

In the case of one unit which normally depends upon support at the chassis front face it will be necessary to fit a small simple bracket to the underside of the chassis.

As the depth of the coil units vary from one brand to another it will be necessary to set some brands away from the chassis on bolts of suitable length so that the switch shaft aligns with the other controls. Incidentally, the location of the unit may mean the use of an extension for the switch shaft depending upon the length of control shaft required for your particular cabinet.

The choice of frequency coverage for the coil unit is a matter of individual choice. There are two stan-

dard ranges for dual-wave units—13 to 42 metres and 16 to 50 metres. It so happened that in this set we used a unit having the latter range.

The ease of wiring of this set will depend somewhat upon the amount of experience had in this direction, although if you have tackled a bit of this work before and can read a schematic diagram the underchassis photograph will tend to fill in the "gaps" for you.

In the early stages the main point is to assemble the major components and the valve sockets, fitting the sockets in such a way as to favor the general progression of wiring from one stage to another. With a ready-punched chassis a socket can be fitted in two ways only. With the circuit diagram in front of you, check the routes of plate and grid leads and select that position of the socket which tends to keep these leads apart and of the shortest length. These same remarks apply also to the IF transformers.

When the appropriate pins of the sockets are earthed, the heater circuit wired and the straight wiring runs in place, the minor components can be put into place. Again, the underchassis photograph will assist here. Just before doing this, place a run of light-gauge tinned copper wire around to all the "earth" points on the chassis.

At first sight the method of connecting a pick-up to the set may seem a little odd. The story here is that provision has been made to permit the use of the "Playmaster" control head featured recently in the series of quality amplifiers and again in this particular issue.

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Simply send us a stamped, self-addressed envelope, together with a sheet of paper containing your name and address (PRINTED—clear enough for us to read). List on the left side, one under the other, the radio parts that interest you. The day we receive the list we'll fill in the latest prices and return it to you, holding the prices for 10 days. Then you select the parts you want and send us the sheet as your order, together with remittance for cost including postage or freight. Goods will be sent same day and any surplus will be credited to your account or refunded as you direct. Simple, but efficient, so we invite you to try this speedy service. Remember, if the parts you want are available, we have them, or will get them for you. Sorry, no C.O.D.'s.

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3/8 x 7/16 S.A.E.	1 MAGNETO SET
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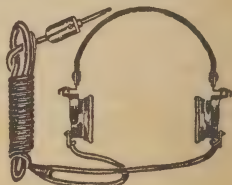
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DEPT. R., 70 OXFORD STREET, SYDNEY.

The six-pin socket concerned allows the heater and high tension voltages to be supplied to the control head and the output from the head to be taken to the audio section of the set. The dotted connections in the diagram indicate the required connections to supply these voltages.

Actually, this control head is a device which provides the necessary compensation for all current types of disc recordings and preamplification for lightweight magnetic pick-ups. If you do not have this in mind, a crystal pick-up, whether lightweight or not, can be fed through a six-pin plug directly into the set, two pins only being used.

TYPE OF SHIELDING

The wiring from this socket to the "radio/pick-up" switch, from the detector diode load resistor and from the switch to the volume control can be in the usual shielded hook-up wire. However, from the moving arm of the volume control to the grid of the 6SJ7-GT the run should be made in low-capacitance shielded cable such as PT1M to avoid undue treble loss when the volume control is used in any position other than "full-on."

The final point concerns the earthing of the braid of the shielded wiring or cabling. Generally speaking, avoid any earthing to the chassis other than at a point or points close to the detector circuitry or the grid circuitry of the 6SJ7-GT. Indiscriminate earthing of this braid may introduce chassis eddy currents into these circuits, with consequent annoying result.

The alignment of the coil unit is usually covered in instructions given with the unit on purchase. Failing this, just remember that the coil slugs must be adjusted only when the tuning is set toward the low frequency end of either range and the trimmers adjusted when the tuning is toward the high frequency end of the range.

The oscillator coil slug for each range sets the alignment of the stations with the dial markings, such adjustment being carried out toward the low frequency end of the tuning range, the aerial and RF slugs then being set for maximum volume. Similarly, the oscillator trimmer is used to set the tracking toward the high frequency end, the aerial and RF trimmers then being set for best results.

For those who may want to know more about the alignment procedure we can supply a pamphlet through the postal query service.

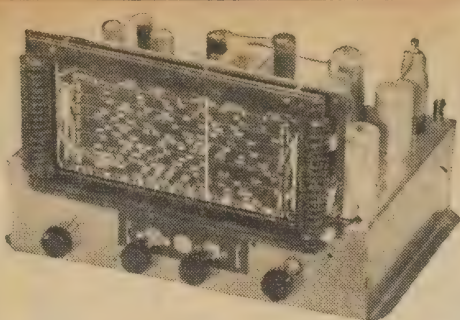
CHECK VOLTAGES

ALWAYS check the filament voltages of your receiver or amplifier to make sure they are correct.

Modern transformers made by reputable factories are quite dependable, but it, sometimes happens that a winding is below voltage, or incorrectly marked.

Valves which require very little cathode current will often work quite well with 5 volts instead of 6.3 volts, but output valves and rectifiers do not like low voltages.

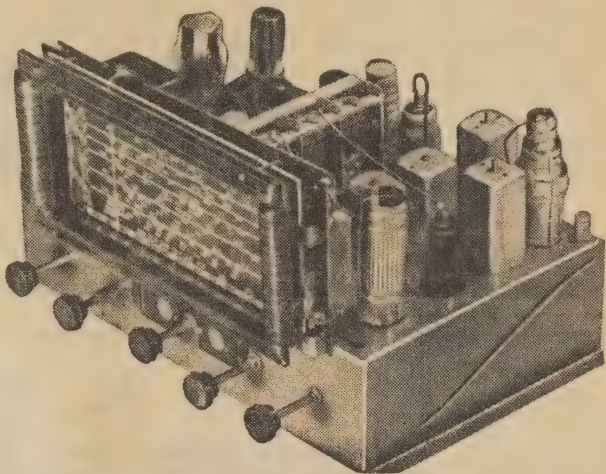
Don't take risks with 807 grid caps. These valves often use voltages of 400 or more, and can give you a nasty "bite." Use insulated caps for them and be sure.



5 VALVE DUAL WAVE RADIO CHASSIS

Complete with 8"
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This 5-valve dual wave chassis is suitable for use in a radiogram, and is fitted with pick-up terminals ready to be attached to a record player. It can be used with either magnetic or crystal pick-ups, and is supplied complete with escutcheon plate for the large, edge-lit, clearly marked dial. Price £23/15/-. Size 15" x 10" x 9½" high. Valves used: ECH33B, 6SK7G, 6SQ7G, 6V6G, 5Y3G. Supplied with 12" speaker in lieu of the 8". £25/15/-.



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Here's value only to be found at Radio House Pty. Ltd. This ready-wired and tested chassis is complete with valves and 12" permagnetic speaker. Complete in every detail, it's easily fitted into your radio cabinet and can be supplied with a polished wood front panel. Ideal for overseas short-wave reception, fitted with phono pick-up terminals, and has tone controls for treble and bass boost.

Dimensions: 16" x 10½" x 9" high. Weight when packed in crate: 63lb.



Front view with
panel attached.

With 12"
Permagnetic
Speaker.

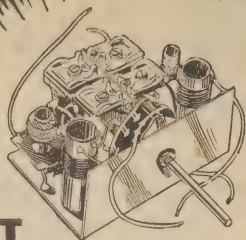


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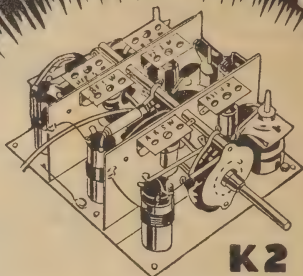
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K2 KIT

R.F. Dual Wave Assembly. Permeability Iron-cored both B/C (500-1600 Kc.) and S/W (7-22 Mc.) Coils. Special cadmium sub-chassis with A.W.A. Air Trimmers, fixed Mica B/C and S/W Padders fitted. Easy and comprehensive colour code and aligning instruction sheet supplied.

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FROM THE SERVICEMAN WHO TELLS

Having reviewed the three main instruments, which form the serviceman's "pieces de resistance", there remain a number of items which fall variously into the classes of auxiliary what-nots and luxury equipment. My choice for discussion this month is a very handy auxiliary item, namely the Universal speaker.

If not already the proud possessor of an auxiliary speaker unit every serviceman will certainly be familiar with the circumstances which make one very handy.

You go out on a job to find that a power transformer has blown in an otherwise good set, making it necessary to take the chassis back to the shop for repairs. You know perfectly well that the speaker is okay and it seems silly to go to all the trouble of unscrewing it from the baffle and carting it back to the shop only to repeat the process in reverse when the set is returned. Result—you leave it behind!

NO SPEAKER?

Then again, somebody from out-of-town drops a chassis on to the counter, neatly wrapped in brown paper, with the terse request to "fix the thing." It may not have dawned on the owner that the speaker could be at fault, with the result that it still nestles snugly in the cabinet.

Either way, you find yourself having to test a chassis without the speaker which belongs to it. You may be lucky to have one on hand which will plug straight in, but there are inevitably the odd sets with unusual pin arrangements or odd combinations of field and transformer. When this happens you reach for the iron to improvise connections.

Either that or you stolidly refuse to test any set until the customer brings in the speaker as well, notwithstanding the chances of a screw-driver or a couple of fingers through the paper cone!

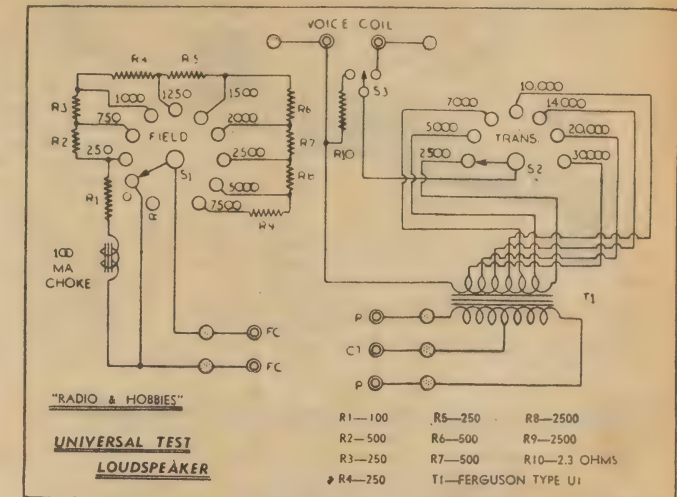
The Universal Speaker is not so much an instrument as it is a gadget designed to solve these very real problems and, incidentally, to save a lot of time in the process. I've used one for as long as I can remember, and if I were setting up a new shop it would be one of the first things to go on the shelf.

Well, now, what must the unit do? First and foremost it must be adaptable to any field speaker socket on a receiver.

SOCKETS

Far and away the most popular sockets are the standard four-pin and the standard five-pin, with an increasing number of the miniature four-pin variety. There's another brand of plug and socket, also, which attaches to the speaker rather than to the chassis. That makes a likely total of four plugs which must be catered for.

Although there are conventional ways of connecting to four and five-pin plugs, variations do occur, making it necessary to have means whereby the field and transformer connections can be switched about. Just to be difficult, some sets come with only the voice coil leads brought out, while others contrive shorting links,



Circuit of the loudspeaker unit referred to in the text.

designed to safeguard the filter condensers.

Although switching might cover most of the variables, the only really universal method, as far as I can see, is a system of patching, which allows any lead from the aforementioned plugs to be connected to any function in the test unit.

As for the unit itself, it must contain an output transformer capable of operating with either single or push-pull valves and reflecting a representative range of load resistance values. This will normally entail a switching operation to vary the number of primary or secondary turns in use—it really doesn't matter which. The secondary side of the transformer feeds into a permag. speaker mounted either in the unit itself or on a handy baffle.

THE TRANSFORMER

Well, then, how good should the transformer be and what kind of speaker is it best to choose?

This looks to be a case where the "nothing but the best" motto breaks down. The nearer you can get to "average" quality the more representative will the results be of those which can be expected from ordinary receiver components.

I've measured a few "ordinary" output transformers in my day and got efficiency figures between 40 and 60 pc in the middle of the range, with unmentionable results at both ends. I don't imagine, either, that the speakers ranging from decrepit 8in jobs through to the "magnetless" 12in monsters are exactly in the hi-fi

class, nor are radio cabinets the ultimate in baffling technique.

If the Universal Speaker is to substitute reasonably for the original and not give an inflated version of the set's performance there is a definite point in being satisfied with a modest transformer, with a modest speaker, a modest baffle and all at a modest price.

IMPEDANCES

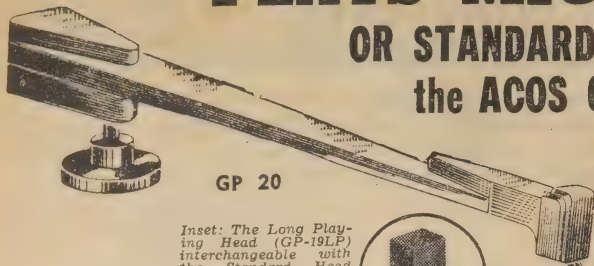
On this same "modest" basis there isn't much point in being too fussy about impedance values. For single output valves loads of 3000, 6000, 10,000 and 15,000 ohms come close enough to published "optimum" figures, while 6000, 10,000 and 15,000 should meet most of the push-pull requirements. There's no harm in having a wider selection of values, but I don't attach much importance to them.

The same general remarks go for the dummy field circuit, which will normally involve a filter choke in series with a variety of heavy duty resistors.

The network should be capable of handling up to about 125 milliamps for a large set, anything above that coming into a pretty specialised class. The main values are 750, 1000, 1500, 2000, 2500 and 7500 ohms. There's no harm in having more values than this, but, once again, I don't regard the extra values as being very important.

Quite a modest choke can be used in the dummy field circuit, since it will normally be replacing a field coil having modest inductance. I'd

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G.P.19 L.P. head £3/7/6

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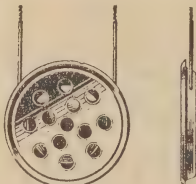
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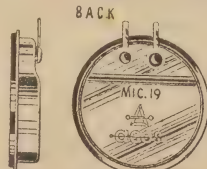
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saying that 12 henries at 225 milliamperes would be a generous figure.

One other facility can be added to a universal speaker, namely an in-built output indicator. It needn't be elaborate but it is handy for alignment purposes to obtain a meter deflection by simply flipping a switch.

Some Universal Speaker units with this facility also have a built-in resistance load which can be substituted for the speaker voice coil. You can then align a receiver in silence, if you want to, or let it run on the test oscillator for hours on end with the output meter available to show any intermittent variation in level.

The next question is whether to buy or to build? Strangely enough, Universal Speakers aren't readily available in many brands, possibly because most servicemen build their own. For those who prefer to buy the commercial instrument it should not be difficult to choose what is wanted in the light of the foregoing remarks.

OTHER COMPONENTS

On the other hand, having purchased a suitable output transformer for a Universal Speaker the rest of the components amount to a collection of switches, resistors, a choke and some hardware which any serviceman can profitably put together in a few spare evenings. The result will never be on public display, so that it needs to be efficient and useful rather than photogenic.

I would say, therefore, that the odds favor "rolling your own" with this particular item.

In this connection, I have prevailed on the Editor to reproduce the circuit of the standard "Radio & Hobbies" unit, for those who may be looking for a circuit to follow.

A possible addition would be a simple output indicator, although the ordinary AC-DC multimeter can be used, where necessary, on the output scale.

To add an output meter to the instrument itself, the simplest way would be to switch the voice coil winding of an oddment output transformer, as shown, across the secondary of the universal output transformer. The secondary of the extra transformer can then feed into a rectifier, a milliammeter and a series resistor, all of which might well be oddment components. The resistor can be selected to give adequate meter deflection on a moderate-level output tone, so that it can be flicked in and out of circuit, as required, during alignment.

USEFUL COMPONENT

As I said earlier, I have used one of these devices for as long as I can remember and have learned to make a few allowances for it, because it is better than some speakers, equal to most and inferior to a few others.

In very old sets, the speakers are often themselves faulty, either for mechanical reasons or by corrosion in the field coil or transformer. Unless the failure is obviously and only in the chassis, I like to have the speaker on hand for a final overall test.

Another point is that many of these old speakers have no hum-bucking coils, with the result that the hum level is likely to be high. If judged only on the test speaker, a chassis may be passed as okay, which could really do with a few more microfarads in the filter. So much for

A simple output meter circuit which can be used with the universal loud speaker unit. It is particularly good for alignment of receivers.

the subject of instruments and gadgets.

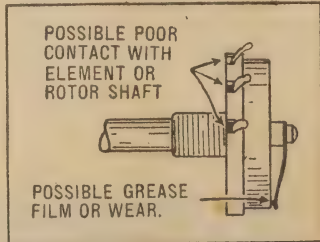
Coming to the actual business of servicing, I've had two interesting cases of intermittent reception this month. The first chassis had already been back to the shop twice for the same trouble and each time had stolidly refused to show any signs of temperment, notwithstanding a deliberate amount of banging and prodding. What could I do but take it back to the owners on each occasion and meekly explain that I could find nothing wrong with it. I don't like having to make such an admission but what can one do when a set just won't go *wrong* when you're around?

It could hardly be the house or locality either, because another set in this home played perfectly and both were provided with a reasonably good aerial and earth.

It says much for the patience of all concerned, when I was called back the third time—and actually answered the call! "Nice people with nice faces . . . &c."

"Yes, the set was still fading and making funny noises but the volume control was now giving trouble. Could I please fix it?"

The control was definitely noisy, however, and I put in a new one. Imagine my surprise about a fort-

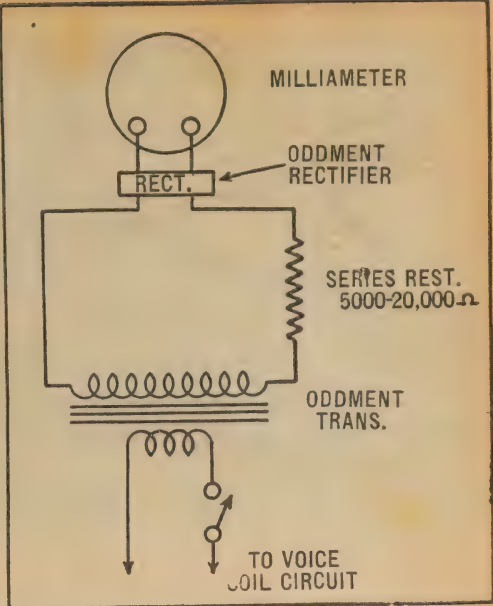


Some weak spots with potentiometers.

night later to learn that the set wasn't fading any more and, as far as I know, it still isn't doing so.

Unless something else righted itself in the meantime, I can only assume that a worn spot or a film of grease between the contact and the element had been responsible all the time for the erratic behavior. While I would not normally have suspected the control, I do know that poor contact inside the works of a "pot" can give rise to a lot of trouble. Here's hoping!

The second set yielded its secret



as the result of some combined sleuthing on the part of the owner and yours truly. It made occasional popping noises with a variation in volume, either up or down. As before, the set played perfectly for me.

The most usual explanation for this kind of thing centres round the fact that a good deal of the incoming signal arrives at the set via the power mains. When extra circuits are switched in or out, the signal pick-up through the mains is affected, resulting in a rise or fall in signal strength, usually accompanied by a loud "plop."

Complaints of this kind used to drive us mad in the days before AVC became a standard fitment in sets, the variations in volume often being little short of spectacular. An efficient AVC system still lets the plops through but irons out the volume changes pretty well.

WIRING FAULTS

Similar changes come about from poor contact between lengths of conduit or bad earthing of the whole system. One case I came across recently involved an intermittent contact between a length of conduit under the floor and the leaden damp course in the house foundations.

Not wishing to waste a lot of time over a fading set, I explained the situation to the owner and suggested that, to begin with, he increase the length of the aerial and run a temporary earth wire to the nearest water tap. These steps, he reported later, made absolutely no difference to the set's behavior.

As a next step, I loaned him a line filter, thinking that this might clear up the trouble but, again, the answer was in the negative. It began to appear now that the trouble was in the set itself.

Now the set was fitted with a magic eye tuning indicator and it occurred to me that this might have a story to tell, if watched carefully. The significance of this was explained also to the owner, who was instructed to take careful note of the

(Continued on Page 100)



EXPERIMENT 1. Charge an ordinary plastic rule with electricity by rubbing it briskly with a piece of woollen cloth. If you hold the charged rule near your finger tiny sparks will be produced.

of course, because you need only understand the mathematical calculations if you wish to become an engineer. A clear understanding of the basic principles is the main requirement. Even some of the old hands have half forgotten, or never had a clear understanding of some of these basic principles and will enjoy the experiments.

One point. You will enjoy the articles and learn much more if you actually carry out the experiments for yourself. Having tried the experiment we describe, you will find that two or three others will suggest themselves and in no time you will clearly understand what seemed puzzling at the first reading.

THE EXPERIMENTS

There isn't any need to continue in this strain any longer because all the experiments are so interesting that you could not help but want to try them for yourself.

First of all you will want to know what electricity is and probably, too, you would like to understand how it is generated. Unfortunately, these questions cannot be answered in six easy words. Electricity is not something that you can wrap up in a parcel and carry home under your arm or buy at the local hardware store at 6d per foot. Nevertheless, it is just as real and tangible as a pound of steak or a length of timber.

A pair of wires look just the same

For the young experimenter

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Every motor car, bus, tram and train in the country would be quite useless. To go to work or school you would either have to walk or ride a horse. No aeroplane would be able to take off and our ships would have to go back almost to the days of sail.

RADIO AND TELEVISION

Our modern radio, too, depends on electricity and, without it, your favorite singer or radio announcer would perform without anyone but himself to be aware of it. Television, radar and the countless other things we take for granted would be quite impossible without electricity.

Most boys want to learn about electricity. Some become so interested that they go to college and study to make it a lifetime career. Others find in electricity and its allied subjects a fascinating and useful hobby to occupy their minds when they are not concerned with the mundane problems of earning a living.

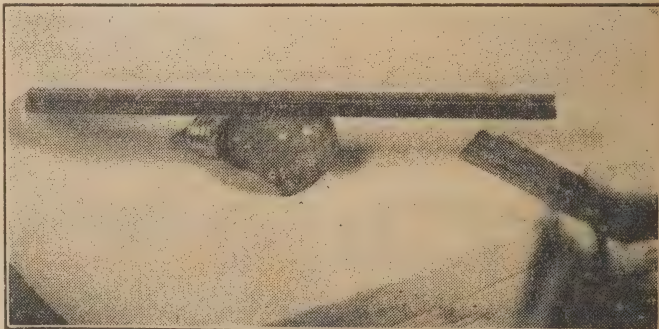
Whichever way it is in your case, you will be interested in this new series of practical electrical experi-

ments. All the experiments can be performed at home with available or easily obtainable materials. We will show you how to teach yourself about electricity by carrying out the experiments described. Many of the experiments are similar to those you would carry out if you were to attend a special school to learn about these things.

We have omitted the mathematics

whether they are electrified or not but only the electrified wires will light lamps, drive powerful motors, &c. If you see a stream of water driving a water wheel it is quite easy to understand where the power is coming from but not so with the electric motor.

How then do we tell if the wires are electrified? Well, there are special instruments which can be connected



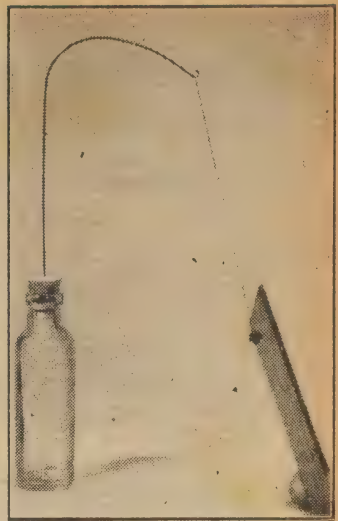
EXPERIMENT 2. Balance a rule on a golf ball or an electric light globe as shown above. A charged object held near the balanced rule has the power to move it without the two bodies touching.



EXPERIMENT 3. Hold a charged rule near a stream of water as shown above. Note how the force exerted by the charge deflects the water from its normal path.



A simple electroscope for studying the effects of electric charges. If you cannot find the parts at home they can be obtained from any chemist for a few pence.



EXPERIMENT 4. Hold the charged rule near the cork cube. The rule will attract the cork as shown in the picture. We use cork because it is light.

to the wires to detect the electricity. Of course, you could grab the wires with your hands and feel a tingle or an electric shock, depending on the amount of electric current passing through your body, but we certainly don't advise this latter method. It can be very dangerous, especially where the power mains are concerned.

The electricity in the clouds makes us aware of its presence by means of the lightning flash. The clouds generate a tremendous amount of electricity. If it were possible to attach wires to a cloud when it is charged with electricity it would be possible to drive many large machines. Unfortunately, up to the present time, no one has discovered a practical way of using this electricity and it is all used up in making the brilliant flash and thunder of a storm.

However, on a small scale we can generate electricity exactly as is generated in the clouds and made evident during a storm.

GENERATING ELECTRICITY

If a plastic rule is rubbed with a piece of woollen material it can be given a strong electric charge quite easily. Take an ordinary plastic rule and rub it briskly several times on your coat or trousers. Then, bring the part of the rule you have just rubbed close to the knuckle of the other hand. When the rule is within about 1-8 in of the knuckle you will hear a faint but distinct click.

This is caused by a miniature electrical discharge. The click corresponds with the noise of thunder in a storm. Try the experiment in a darkened room and if you watch carefully you will be able to see the faint flash of light accompanying the discharge.

By rubbing the rule, you have generated what is called "static" electricity. The friction of the air on the clouds generates static electricity in much the same way.

By the way, when we speak about "static" electricity we simply mean electricity at rest and in the following experiments we are going to show you some of the things that can be done with a charge of electricity at rest.

If, as we will later on in the course, we arrange things so that the charge can move from one place to another we have what is called a current of electricity and with this current of electricity we can produce a whole new series of effects. The lighting of an electric lamp and the turning of an electric motor depend on the effect of current electricity but, except that it is moving, it is the same thing as static electricity. There is only one thing called electricity.

STATIC ELECTRICITY

On a cool, dry day using a perfectly clean and dry plastic rule you will be able to make the miniature spark jump up to 1 in with a sharp and distinct click. If you run your finger along parallel to the rule and close to it you will hear a series of clicks as you discharge the full length of the rule. Sometimes it is possible to light a gas jet with the sparks from a charged ruler. Try this experiment with the gas jet just turned on, otherwise the force of the gas will tend to quench the spark.

Experiments with static electricity will all work better on cool, dry days since damp air is a partial conductor

of the electric charges and allows them to leak away before you have a chance to observe them. Breathe on the rule just before you try rubbing it and you will find that it is much harder to get a detectable click.

Besides producing miniature lightning discharges, electricity has the power to attract and repel things. This is quite easy to demonstrate with a charged rule and a small scrap of paper.

Cut a small scrap of light writing paper to about 1 in square and after rubbing the rule hold it near the paper. The paper will jump up suddenly and cling to the rule as though it were attached with paste. After a little while it may jump away from the rule just as suddenly as it was attracted. With a strong charge on the rule the paper will do all kinds of apparently inexplicable things.

Another experiment, and one which almost has to be seen to be believed, also demonstrates the physical force of an electric field.

FORCE OF FIELD

Adjust a water tap so that a smooth stream of water flows and then charge the rule by rubbing it briskly. Then hold it near the water. If there is a good charge on the rule you will be able to deflect the water several inches from its normal path.

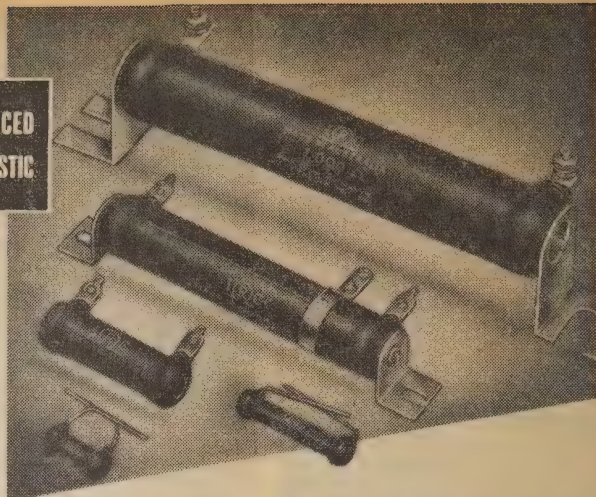
By the way, due to leakage through the air, the rule will not hold its charge indefinitely but a few brisk rubs will restore the charge to full strength.

Yet another way to show the force of an electric charge is to balance a rule, which may be either wooden or plastic, in such a way that it can be turned easily. A golf ball or the rounded top of a bottle will serve. The idea is to find something which allows the rule to turn easily and yet is reasonably easy to balance it

by Maurice
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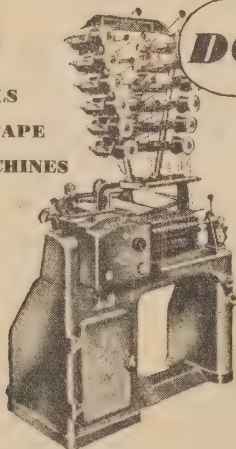
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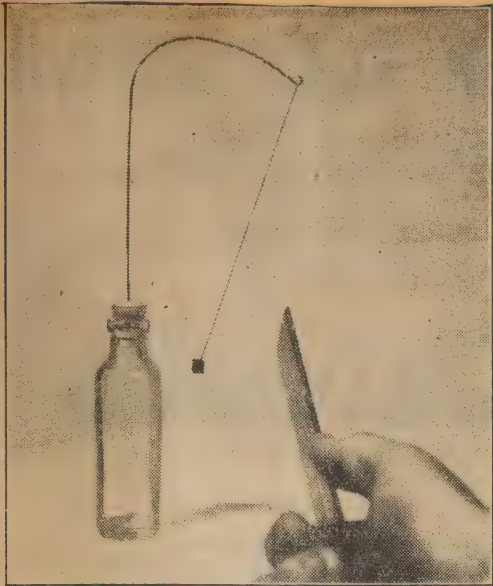
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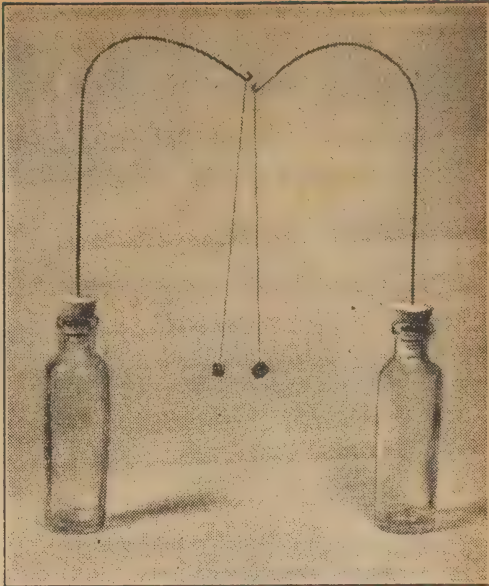
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EXPERIMENT 5. Charge the cork cube by allowing it to touch the charged rule. Both the cork and the rule will have the same charge and will repel each other.



EXPERIMENT 6. Charge both electrosopes from the rule and then push them together. Note that they repel each other. This is similar to Experiment 5.

on. Charge the plastic rule as before and hold it near the end of the rule you have just balanced. Without touching the two rules the attractive force will probably be strong enough to pull the uncharged rule off balance.

While the experiments with the scrap of paper, the rule, and the stream of water illustrate very clearly the attractive force of an electric charge you can learn quite a lot more about electric charges by constructing a special little instrument, called an electroscope, to study them.

Scientific supply stores have electroscopes for sale but we used a few odds and ends to make the electroscope shown in the photographs. It is very simple to make as, essentially, you need only have a small cube of cork and a piece of silk or nylon thread. In our case, a small bottle with a cork fitted to the top, bought at the local chemist-shop for a few pence, was made to serve as a stand.

THE ELECTROSCOPE

Push the cork firmly into the bottle and then push a piece of wire into the cork, bending it to a shape something like a walking-stick, as shown in the photographs. At the "handle" end, bend the wire to form a small hook so that the thread can be attached.

The important part of the electroscope is a small light ball or cube. The classical material for this is the pith from the elder plant, but we have had excellent results with a cork cube having a side about 3-16in long. To improve the electrical conductivity of the cork it was rubbed on all six sides with a soft lead pencil. Most of the experiments will actually work without this but we found that the instrument be-

haved more nearly according to plan when the surface cube was made a good conductor.

The supporting thread should be very fine and a good insulating material. Silk or nylon from an old stocking is excellent. To attach the thread to the cube, cut a slit in the latter with a razor blade and push the thread into the cork. Knot the thread around the hook in the supporting stand so that it is about 8in long. We actually made two electroscopes, both exactly the same, so that we could study the behavior of the cubes in relation to each other when they were both charged.

ATTRACTION AND REPULSION

Now, charge the rule and bring it close to the cube of the electroscope. You will find that the cube will jump to the rule and cling quite firmly for a few minutes and then just as suddenly jump back away from the rule, trying to get as far away from it as possible.

While you have been doing this the rule will have lost some of its charge so give it a few more brisk rubs. This time you will find that it is almost impossible to bring the rule in contact with the cube. Try as hard as you like but the cube will always jump away from the charged rule, due to the invisible electric force. Wipe your hand across the rule and you will be able to bring it close to the cube without difficulty.

If you have made a pair of electroscopes you can charge them both by touching them with the charged rule. To get a good charge on each you will need to rub the rule a second time before applying it to the second cube. Now, push the two electroscopes together. Note that the two cubes do not come together but keep a little way apart.

Actually this is an example of the same phenomenon as in the previous experiment. Both the cork cubes have the same sort of electrical charge and they repel each other.

Up to date we have been experimenting with the one particular charge of electricity produced by rubbing the plastic rule with wool or flannel. However, it is also possible to produce electricity by rubbing a number of other pairs of materials together. Rub a length of glass rod with a silk pad and hold it near the cork cube of the electroscope. Note that it behaves in the same way as when influenced by the rule. First it is attracted and clings to glass but after a few seconds it jumps away smartly from the glass and from then on tries to keep as far away from it as possible.

Try charging the cubes of both electroscopes from the glass rod. Note that they repel each other just as they did when charged from the rule.

UNLIKE CHARGES

Now, charge one of the electroscopes from either the glass rod or the rule. (Sometimes it is possible to get a stronger charge from the rule, so we will assume that you use the latter.) Recharge the rule and hold it near the cube which will be repelled as before.

Now, without touching the electroscope, charge the glass rod by rubbing it with the silk and then hold it near the cork cube. This time, instead of being repelled, the cork cube is attracted to the glass.

Since the charge on the cube has not been altered and it is repelled by the charged rule but attracted by the charged glass, we gather that

(Continued on Page 95)

A.C. POWER FROM D.C. SUPPLY

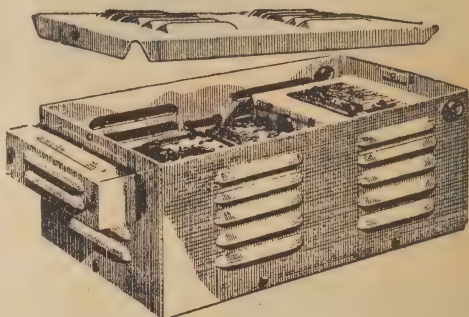
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A COURSE IN TELEVISION

PART 30 . . . THE FM SOUND CHANNEL

Most television stations now in operation use an FM system for the sound channel. Although a series of articles on FM appeared prior to this television course, it is appropriate that we summarise the relevant material for the sake of new readers.

IT is standard practice now to radiate the FM sound signal in a channel immediately adjoining the video signal and separated from it by a predetermined number of megacycles. For example, American practice is to separate the sound and vision carriers of all stations by a figure of 4.5Mc.

The receiver aerial and tuning systems are kept sufficiently broad in their response to receive and amplify both carriers simultaneously and both are heterodyned by the local oscillator to produce separate and distinct intermediate frequencies. Since the separation between the two carriers is kept constant, the same two intermediate frequencies are produced from each station as it is tuned.

Common practice is to select an IF for the sound channel in the region 21-22Mc, and at about 25-26Mc for the video channel.

Both frequencies appear in the output of the mixer stage and are diverted by suitably tuned circuits into completely separate IF amplifier channels.

The video signal, as we have seen, passes through an extremely wide band channel to the video detector, thence into the video amplifiers. After the sync. pulses are extracted and the DC component restored the video signal is fed ultimately to the grid of the picture tube.

FM IF CHANNEL

The sound signal, on the other hand, passes through its own IF channel, thence into an FM detector of one type or another, finally to the audio amplifier and loudspeaker.

Apart from the fact, therefore, that it shares the RF section with the video signal the sound channel of a television receiver closely resembles a conventional FM receiver.

The chief point of difference are (1) an IF of about 21 rather than 10.7 Mc is normally employed, and

(2) the maximum frequency deviation is usually limited to about 25 rather than 75Kc.

Despite this reduction in carrier deviation it is usual to make the sound channel somewhat broader than necessary in its response, to minimise possible difficulties with tuning drift at the higher signal frequencies.

The aim, therefore, in designing the sound IF channel, is to achieve the requisite band width and gain and the solution involves the now

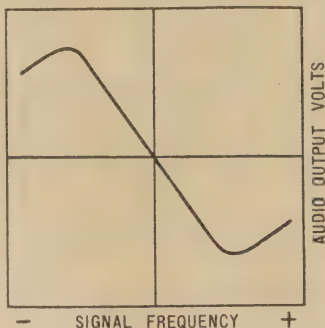


Fig. 1. Curve for FM detector.

familiar pattern of overcoupled or loaded transformers, combined with high-transconductance valves. The usual practice is to use two or three IF amplifier stages with either three or four associated transformers, according to the price bracket of the receiver.

Details of the IF channel design actually depend a great deal on the choice of FM detector, of which the two most popular are the "ratio detector" and the "Foster-Seeley discriminator."

The ratio detector is inherently insensitive to variations in amplitude

so that, when properly set up and adjusted, it rejects much of the noise interference which may be present along with the signal. In this case the IF amplifier stages can operate in a perfectly normal fashion as class A amplifiers.

The Foster-Seeley discriminator is responsive, however, to both frequency and amplitude variations, so that it does not of itself reject interference, which is predominantly AM in character.

To achieve this rejection it is usual to operate one or more of the stages preceding the Foster-Seeley circuit under very restricted conditions so that they limit any sudden rise in amplitude above the average figure. Noise pulses are thus suppressed before reaching the detector.

There is not a great deal to choose between the two systems because the Foster-Seeley circuit makes up, in added detector resolution, what it loses in gain from the unusual operating conditions of the preceding stages. Both systems are worthy of study, however.

DETECTOR CONSIDERATIONS

The major exception to this practice is provided by the system known as "inter-carrier" reception, which will be dealt with later in a separate article. It is extremely important and may well become standardised practice in local receivers. Briefly, it involves passing both sound and vision signals through a common IF channel before its ultimate application to the FM detector and audio system.

The reader should not have any special difficulty in understanding the variations in IF channel design, the major difficulty being rather to appreciate the operation of a detector which converts variations in frequency to audio signal volts.

Part of the complication surrounding an FM detector arises from the fact that the change in a frequency-

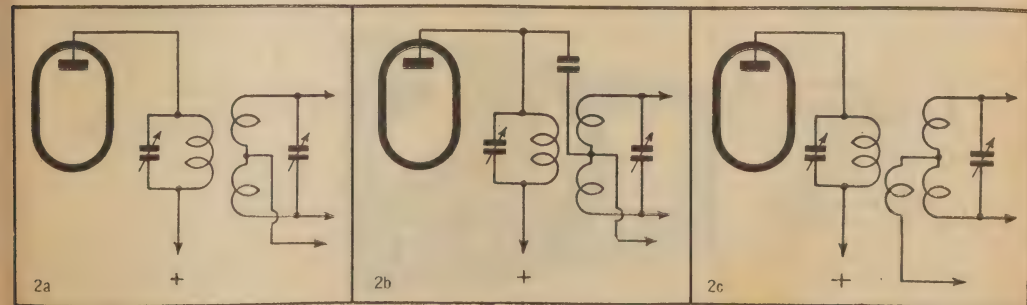


Fig. 2. Showing transformer circuits using the three circuits discussed in the article.



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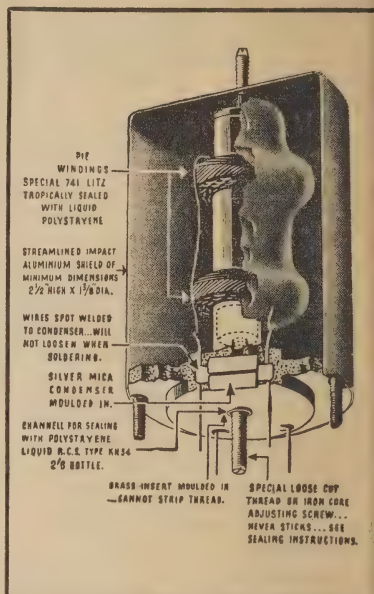
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modulated carrier is much less positive, in effect, than in an AM carrier. In the latter case full modulation varies the amplitude from zero to twice its static value—a variation of plus and minus 100 pc.

In the case of an FM carrier the amplitude is constant, and full modulation represents a change in frequency of less than 0.1 pc. Even referred to the intermediate frequency of a receiver, the deviation is still less than 1.0 pc.

From this comparatively small percentage deviation the FM detector had to derive a substantial audio signal, and it is little wonder that its design and adjustment are rather critical.

An FM detector has to exhibit a curve similar to figure 1, which shows audio output voltage plotted against deviation of signal input frequency.

The straight portion of the curve must be sufficiently wide to include the maximum frequency deviation, which, in the normal way, will be plus and minus 25Kc. If its characteristic is not linear over this full range the detector will introduce harmonic distortion in the output.

AUDIO OUTPUT

The slope of the curve should also be as steep as practicable, indicating a high audio signal voltage for a given deviation in carrier frequency.

A complete FM detector circuit can really be divided into two parts, namely, the detector valve itself and the IF transformer which feeds it. With both the ratio and Foster-Seeley circuits the transformer is a specially designed unit, which is particularly responsive to variations in carrier frequency. As we shall see, the key word in considering the operation of this transformer is "phase."

Consider an IF transformer, as in figure 2a, with a tuned primary and a tuned secondary, the latter winding being centre tapped. Signal currents passing through the primary induce voltages in each half of the secondary, which are equal, but 180 degrees out of phase.

The voltages remain equal, whether or not the signal frequency happens to correspond with that to which the transformer is tuned. It is, therefore, of no immediate assistance in dealing with a frequency modulated carrier.

What is obviously required is some treatment of the transformer which will introduce a condition of unbalance between the two halves of the secondary when the signal frequency deviates to either side of resonance.

PHASE RELATIONSHIP

Having obtained this dependence on signal frequency for balance or unbalance, it then becomes a relatively simple matter to extract the audio component.

Exactly the effect we want can be achieved by connecting a condenser between the "hot" side of the primary winding and the centre tap of the secondary.

Two effects are now present. A signal through the primary winding will induce out-of-phase voltages in each half of the secondary, exactly as before. In addition, the entire secondary winding, including the outer ends, acquires an RF potential, since it is coupled by a condenser to the preceding amplifier plate.

The signal voltage at each end of the winding therefore becomes the

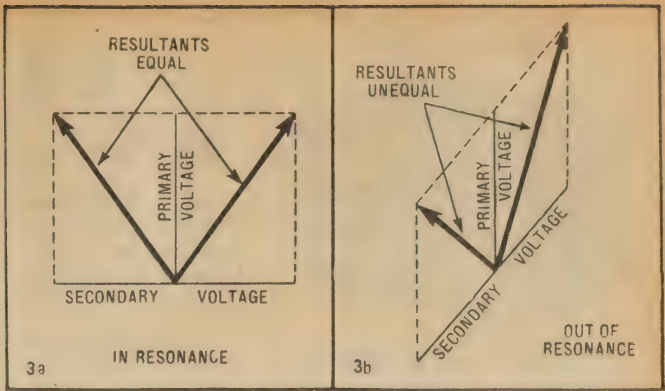


Fig. 3. Vector diagram showing how phase relationships operate in the FM detector.

resultant or combination of the energy imparted to it by the magnetic and the capacitive coupling. This is where phase enters the picture.

When the signal frequency is in resonance with the transformer, the voltages cross each half of the secondary, due to magnetic coupling, and are exactly equal and exactly 90 degrees out of phase with the primary voltage. These are combined with the direct primary voltage, introduced by the condenser coupling, to produce resultant voltages at the transformer ends which have a phase difference but are exactly equal in amplitude.

If you can follow a vector diagram the condition at resonance is indicated by figure 3a.

When the signal deviates from resonance, the voltage applied to the secondary by the coupling condenser remains substantially the same, but the voltage induced by the magnetic coupling shifts appreciably from its original 90 degree displacement.

At the outer ends of the winding the resultant voltages are no longer equal, the different phase relationship tending to add in one case and cancel in the other.

Referred once again to a vector diagram, we have the resultant shown in figure 3b—an off-resonance signal and unequal voltages at the outer ends of the transformer secondary. With an FM carrier the signal swings to and fro at an audio rate and differing voltages appear sympathetically at the outer ends of the transformer secondary. The job is half done!

ALTERNATIVE METHOD

One more point must be made before we pass on. The desired result was achieved by providing normal coupling between the two tuned windings PLUS capacitive coupling to the centre point of the secondary. Much the same result can be obtained by returning the mid point of the secondary to a tertiary winding tightly coupled to the primary.

The result is the same: A balanced signal at each end of the secondary with the signal in resonance, and a condition of unbalance as the signal deviates in frequency either up or down.

The second section of the detector circuit simply translates the varying condition of balance into audio impulses similar to those which originally caused the frequency swing.

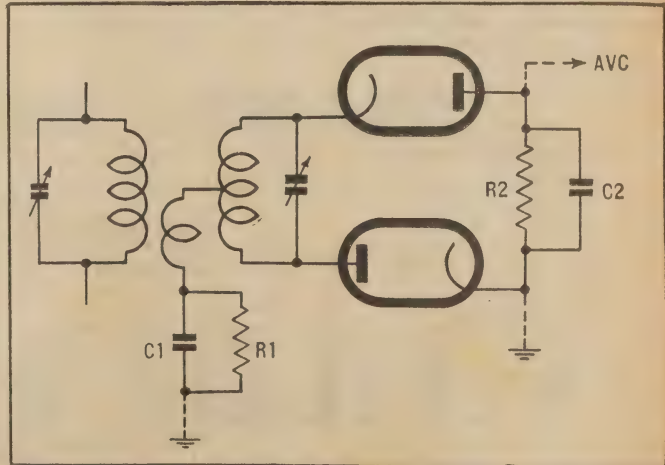
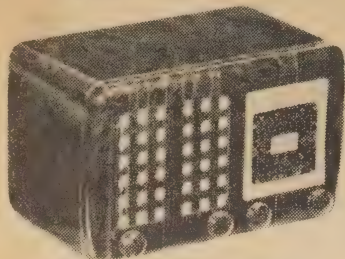


Fig. 4. The essential circuit of the ratio detector.

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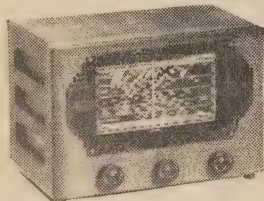
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EXCELAIR RADIO

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We shall consider first the so-called "ratio" detector, which is responsive to variations in signal frequency, but not to amplitude.

Essential features of the circuit are shown in figure 4.

The outer ends of the IF transformer secondary are connected to a pair of diode elements, to cathode in the one instance and to plate in the other. The two remaining elements are connected in series with a common load resistor R2, bypassed by a condenser C2. For convenience, the lower cathode is grounded to chassis.

The tuned secondary is inductively coupled to the primary and a tertiary coil is connected between the centre-tap of the secondary and earth, via a second load resistor and bypass, R1 and C1.

In the presence of a signal, the two series diodes conduct and build up a voltage across R2 and C2, in familiar fashion. In practice, C2 is made very large, giving a long time constant to the combination. Thus the potential across R2 and C2 assumes a certain value for each incoming signal and does not fluctuate with abrupt changes in carrier amplitude due, for example, to superimposed noise pulses.

RATIO DETECTOR

When the signal is in resonance, as with no applied frequency modulation, the voltage across each half of the secondary is the same, and the centre tap therefore assumes a mean potential approximately equal to half the steady voltage across R2/C2. And this mean potential is likewise present across C1/R1.

The combination C1/R1 is given a time constant such that the potential across it can vary, if necessary at an audio rate, the condenser C1 being

essentially an RF bypass only. In this respect it resembles the diode load of a conventional AM detector.

All this assumes that the signal frequency is in resonance with the IF channel of the receiver, and with the discriminator windings in particular.

The moment the frequency deviates from resonance, the balance of voltage across the two halves of the secondary is upset, a great voltage being present in one half of the circuit than in the other.

However, the total voltage across R2 and C2 is fixed, so that the net effect of the unbalance is to alter the potential at the centre-tap and therefore across R1 and C1.

AUDIO VARIATIONS

Thus, as the frequency swings, from one side of resonance to the other, the instantaneous potential at the centre-tap varies in sympathy. This occurs at an audio rate, and the varying voltage appears across R1 as an audio signal.

The detector derives its name simply from the fact that the audio signal is produced by a varying ratio of voltage across the top half of the secondary and the top diode on the one hand, and the lower half of the secondary and the lower diode on the other.

The total voltage across R2 and C2 remains the same for any given strength of carrier.

A burst of noise, as an amplitude modulation, can momentarily alter the current flowing through the two series diodes, but it cannot affect to any extent the steady potential across C2. And the proportion of the voltage across the audio load R1 depends still and only on the instantaneous frequency of its signal.

In practice, the steady voltage

across R2 can be applied readily for AVC, if such is required. For various reasons R2 is generally made about 50,000 ohms and C2 can be as high as 8 mfd. to give the necessary long time constant.

The audio load R1 can be a 0.5 megohm potentiometer, while C1 may have a capacitance approaching .01 mfd. This gives a diminishing treble response to match the rising treble response which has been accepted as standard practice in FM sound channels.

Next month we plan to discuss the Foster-Seeley circuit and the limiter stages which normally must precede it.

EASIER SOLDERING

WHEN making soldered joints, it is important to place the soldering iron on the joint before applying the solder. Merely running molten solder over the joint will not make a permanent bond. The work has to be heated at least to solder heat before the solder will flow. If it is not hot enough, a "cold joint" will result which sooner or later will cause trouble.

Make it a habit to place the hot iron on the joint for a second or two—longer for heavy joints—before the solder. You will find that your soldering is made more easily and quickly as a result.

Lock washers are handy things when building receivers, particularly when used with bolts holding down earthed solder lugs.

A lock washer placed between the chassis and the lug will bite into both and make good contact almost certain. A second lock washer under the nut will make a shake-proof joint.



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The Heavy Duty Avometer is a multi-range A.C./D.C. Meter specially designed as a robust, portable instrument for use under difficult conditions. An automatic cut-out mechanism gives complete protection against overload. This mechanism indicates on the scale plate that it has tripped and may easily be reset ready for use. A single rotary switch controls eighteen ranges of direct readings on 3 1/2-inch scale. The instrument is of the moving coil type, employing a transformer rectifier system for A.C. measurements.

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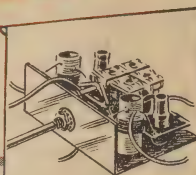
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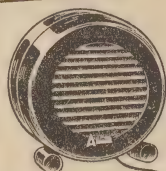
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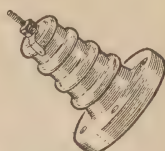
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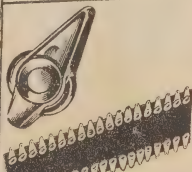
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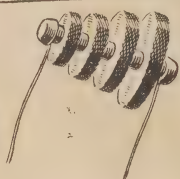
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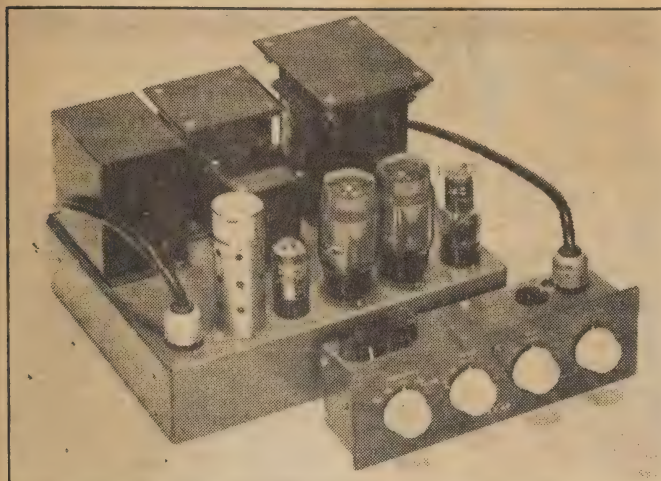
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TRADE REVIEWS AND RELEASES



The Leak Point One amplifier and RC/PA/U Control Unit. The vacant socket provides power for a radiotuner. All input connections are made to the terminal block at the left.

FINE RESULTS FROM LEAK AMP.

The Leak Point One amplifier, well known in England for its high quality is now available in Australia through Simon Gray, 28 Elizabeth St., Melbourne, Victoria. A sample just through our tests bears out in every way the maker's claim for it.

THE amplifier is built in two sections, consisting of a main amplifier and a control unit.

The control unit has input channels for radio, pickup and microphone. A selector switch controls these, and provides correct compensation for 78 and LP records.

Two further controls give degrees of bass and treble boost and cut, and a fourth regulates volume. The volume control has a built-in AC switch which may be used if required.

The amplifier has three stages. KT66 triodes are used in push-pull as the output stage, driven by a most interesting phase-changer circuit. Inverse feedback is used from voice coil to input.

Through the control panel, sensitivity via the microphone channel is 3 mv, through the radio channel 50 mv, and through the pickup channel 15 mv.

The output transformer provides for numerous output impedances between 1.7 ohms and 36 ohms.

IMPRESSIVE AMPLIFIER

This is one of the most impressive amplifiers we have used or tested. Its total distortion—quoted at .02 pc—is obviously very low, and this fact makes the amplifier suitable for many special purposes. Its over-all phase displacement, also, is particularly small, one more point which will appeal to those requiring high quality units.

The control pre-amplifier obtains its frequency compensation by means of a twin-triode valve used in an inverse feedback circuit. Feedback is varied by the controls to obtain the required degree of bass and treble variation. It is particularly smooth in operation, and neat in appearance.

The workmanship of both units is of an extremely high order, and component parts are of the best. Unit construction makes for great flexibility in use. The control unit may be mounted remotely from the main amplifier, or actually bolted to its chassis so as to make a single piece of equipment. As a rule, however, the two will be mounted separately. The control unit is completely shielded, and there is virtually no residual hum level to be heard.

In looks and in performance, the Leak Point One is a very fine piece of amplifier design and construction.

CORRECTION

In the full page advertisement which appeared on behalf of Amplion (A'asia) Pty. Ltd., on page 16 of our September issue, unfortunately, the G.P.11 "Acos" Pickup cartridge featured in the advertisement was incorrectly quoted as G.P.1. The price of £1/19/6, as quoted in the advertisement for this particular pickup is quite correct.

Chancery Attachment for L.P. Records

SINCE the general release of 33 rpm microgroove records, there has been a demand for new multi-speed motors on the one hand, or for attachments which will convert the 78 rpm speed of an existing motor to 33 rpm. Most recent of these to be submitted for review comes under the trade name "Chancery."

The Chancery attachment is placed on any regular size standard or automatic changer turntable (except those changers fitted with a non-removable bent centre spindle—no special fixing is required and the unit is suitable for use with either AC or DC operated motors.

Outward appearance is that of a standard turntable of the usual 10in diameter, but with a depth of $\frac{1}{2}$ in. The unit is robustly manufactured of lightweight alloy, with a durable anodised finish, reinforced by grooves for added strength.

It is desirable that a microcell pickup be used with long-playing records, and the stylus pressure must not exceed 12 grammes.

This basic requirement for microgroove records means, in practice, that the heavy magnetic pickups conventionally used in commercial radiograms cannot be employed and it will normally be necessary to provide a new lightweight pickup having enough output to operate directly into the receiver's pickup terminals.

The agents recommend the Chancery microcell crystal pickup (type G.33 L.P.), for use in conjunction with the Chancery long-playing attachment (G.33). This pickup has the following features:—

1. Wide frequency range.
2. Lightweight plastic - balanced arm.
3. Removable crystal cartridge for easy replacement.
4. Sapphire stylus .001in radius, specially for 33 1-3 rpm records.
5. Increased height to compensate for depth of G.33 attachment.

Total cost (with G.33 pickup), £12/5/- retail (including 33 1-3 sales tax), available from all leading suppliers.

DECCA EQUIPMENT

A new shipment of record players, radiograms, amplifiers and corner speakers from the well-known house of Decca is now being landed here—availability immediate.

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to do without prejudice to what might be said in the future. Let's begin then.

There isn't much point in merely quoting definitions because, as I have already shown, they are open to a good deal of variation with usage. The fact that certain writers define beats and combination tones separately may only mean that they are conforming to what is common acoustic practice. It does not signify unless they specifically say so, that they support or deny any connection between the two.

BEATS BECOME TONES

Sufficient to say that, in one of the most recently issued physics text books for university students, in a chapter on sound, I find the statement that . . .

"If the beats are too frequent to count, they may occur with sufficient rapidity so that they themselves constitute a musical tone."

That looks like another dangerously heretical departure from the orthodox and is only mentioned to emphasise the apparent futility of quoting one writer against another.

Then again, we must realise that the sense of hearing should be analysed on the basis of the ultimate brain stimulus experienced by the observer—not the mere mechanical vibration of the ear structure. This is capable of some analysis but authorities agree that little is known of what happens beyond that.

Let's Buy An Argument

I had intended to forget the subject of musical beat notes for the time being but there has been so much comment, one way and another, that I must perforce return to it. If I appear to be speculating in unfamiliar fields, don't let it worry you, because the whole idea of this column is to provoke thought and discussion.

IT began, you remember, when I followed the practice of many radio authors and referred to the interaction of any two tones as a "beat" effect.

A reader, Mr. McDermott, took me to task over this and pointed out that the term "beat" had a specific and limited application in acoustic terminology and that I should not have confused it with a "combination tone."

Of course, I had to admit the rights of the musical and acoustic fraternity to their own terminology, even though it might not always be adhered to by those interested in other branches of physics.

I then went on to say that there was a grave doubt in my mind as to whether there was a real difference between the phenomena of beats and combination tones and that they may well be like poodles and greyhounds—variations of the one thing.

This brought forth quite a lot of comment, for and against, and I have reproduced on the opposite page excerpts from three letters, one from a practising acoustic engineer, one from a B. Sc. and another from a high school student.

Taken together, they make good reading but do not by any means prove or disprove my original and contentious suggestions. In fact quite a good case can be made to support these suggestions and this I propose

The first point we have to grasp is that pressure waves, whether acoustic or electric, do not necessarily mix to produce a resultant just because they are sharing a common medium. Very definite conditions must exist before we can rightly apply the common term of "adding" two waves.

Let's forget about ears altogether for a while and consider certain other devices about which there may be less confusion. Let's say, for example, that we have available a theoretically perfect loudspeaker.

Into this loudspeaker we now feed a sine wave at some suitable frequency and amplitude. The diaphragm will commence to vibrate and if the instantaneous position of a point on its surface is plotted against a time scale, a perfect sine curve will result.

Now assume that a second sinoidal signal is fed into the speaker along with the first. The diaphragm is

by **W. N.
Williams**

now subject to two separate driving forces and its position at any instant will be determined by the instantaneous values of those forces.

If both happen to be operating in a particular direction at the one instant, then the diaphragm will be displaced further than it would be if only the one force were acting upon it. Conversely, at other instants, the forces might easily tend to cancel.

Now four possible conditions may arise as under:

(1) There may be a **COMPLETELY RANDOM RELATIONSHIP** between the frequencies of the two driving signals.

WHAT CAN HAPPEN

When this occurs, the plot of cone position against time will be of constantly changing shape, because the phase positions of one wave are constantly changing in respect to the phase positions of the other.

(2) One frequency may be a **SIMPLE MULTIPLE** of the other.

In this case, the relative amplitude of the two waves will be fixed and the curve of displacement against time for the diaphragm will repeat itself indefinitely. The condition would resemble the combination of a fundamental with a particular dominant harmonic.

(3) The forces on the diaphragm may have a **RANDOM FREQUENCY RELATIONSHIP** as before, but nevertheless be **WITHIN A FEW CYCLES** of one another.

The diaphragm will follow a path which is determined by the instantaneous sum of the driving forces, exactly as before, but there is a component in its movement which is slow enough to be observed easily and separately.

(4) The two driving forces may be **OF IDENTICAL FREQUENCY**, in which case they will either tend to add or cancel, according to their relative phase.

Now there's nothing at all new about all this. Every speaker cone that ever emitted a programme spends its existence taking up positions of displacement determined by the instantaneous values of all the driving forces acting upon it. And there's normally dozens of them—Spike Jones and all!

There are various ways of analysing the cyclic displacement of a diaphragm, ranging from Berliner's famous demonstrations with carbon black, to gas flames, mirrors and the modern oscillograph.

GRAPHICAL METHOD

As one of our correspondents has mentioned, you can even do it graphically for a simple case, and we had our draughtsman run out some curves by way of illustration. But don't jump to hasty conclusions about those curves. There may be more in them than meets the eye.

However, let's not digress. If we arrange a perfect microphone in front of the perfect speaker we've been talking about, we can reasonably expect the microphone diaphragm to describe the same cyclic movements as the speaker diaphragm. Furthermore, we should be able to recover from the microphone an exact electrical replica of the acoustic pressure wave.

THE CASE AGAINST

I cannot refrain from entering this argument any longer. In the last two or three issues of *Radio and Hobbies* you have stated that beat notes between two pure sine waves are produced by the non-linear response of the ear.

Any High School pupil will tell you that the beats are present before the sound reaches the ear. The non-linear response of the ear has nothing to do with the beats.

The phenomenon of beats produced by two sine waves is the result of the two sine waves periodically coming into phase and consequently reinforcing each other. For example, if two sine waves of frequencies 600c/s and 606c/s are superimposed it is found that they come into phase 6 times per second. Thus, the resultant wave form obtained by adding the two original sine waves is periodic with a varying amplitude. This amplitude is a maximum 6 times per second.

I refer you to any high school textbook on Sound. In particular see the chapter on Sound in "Booth and Nicol." (D. R. W. Lismore.)

Graphical Exercise

With regard to the question of beats, you and all those whose letters you have published are under a serious misconception about beats. Beats are heard only where there is no appreciable non-linearity. If there is any non-linearity, heterodyning occurs.

A beat, to define it simply, is the algebraic addition of two sine waves of frequencies not too dissimilar. If, as I have done in my student days as an exercise, you draw two sine waves on graph paper and add them, the result is a wave which is amplitude modulated at the difference frequency. The frequency is the mean of the two original waves. No sum frequency is present at all.

If the difference is low enough, say less than 100 cps, it can be heard for what it is, a rhythmic variation in amplitude. If higher than this, the beat can still be heard, but the ear does not correctly interpret it owing, I think, to its own AVC action. What we think we hear is a modified wave, and the effect is pleasant or unpleasant according to the energy level and the frequencies involved.

The fact that beat notes can be detected by the ear at low levels does not show the ear to be a non-linear device at all. Another point is that you can't hear beats between supersonic devices.

The estimates for hearing are generally much too low and I personally put the limit around 30 Kc. The frequency response of all links in the reproducing chain should extend to well over this

figure.—W. G. S., B.Sc. (Punchbowl, NSW).

Some Definitions

A number of very informed people employ these two terms so let us see what some of them have to say about them. The Technical Director of the Acoustics Laboratory at M.I.T., Dr. L. L. Beranek, B.A., D.Sc., in his "Acoustic Measurements," gives us the following definitions:—

"BEATS are the amplitude pulsations resulting from the addition of two or more component vibrations of different frequencies which are not harmonically related."

"COMBINATION TONE is a supplementary tone produced when two tones are sounded simultaneously. Combination tones are produced only in connection with non-linear devices, the ear being such a device."

It is interesting to note that in his definition of beats Dr. Beranek makes no mention of linearity whilst in his definition of combination tones he makes note of non-linearity as being a prerequisite to their appearance. Do you suggest that the former is an oversight on Dr. Beranek's part? Is the fact that he gives a definition for each significant?

The Proposed American Standard Acoustical Terminology, sponsored by the Acoustical Society of America, gives this definition of beats:—

"1.170. Beats. Beats are the amplitude pulsations resulting from the addition of two or more periodic quantities of the same kind but of slightly different frequencies."

Unfortunately, I do not have the complete list of definitions but only those appearing as a "Glossary of Terms in Audiology" in "Hearing Tests and Hearing Instruments" by Watson and Tolan. The definition of combination tones is not included. No such definition may exist but I suspect it does as Dr. Beranek (who gives two definitions for what may be one phenomenon) is vice-president of the Acoustical Society of America and Chairman of their Standards Committee and would, I expect, have some interest in the standard terminology.

But back to the last definition of beats. Would you say that the word "slightly" in the phrase "slightly different frequencies" has any meaning? (In my humble way I believe it may). Would you contend it covered a difference of a few thousand cycles?

It would seem that the shade of difference existing between beats and combination tones lies in the way in which they are detected by the inner ear.—J. F. McD. (Darling Point).

But why go to all this trouble? Simply to demonstrate, I hope, that you can pass signals through a variety of common AND LINEAR media

without actually combining them.

If we now provide a series of perfect filters at the output of the microphone, it should be possible to



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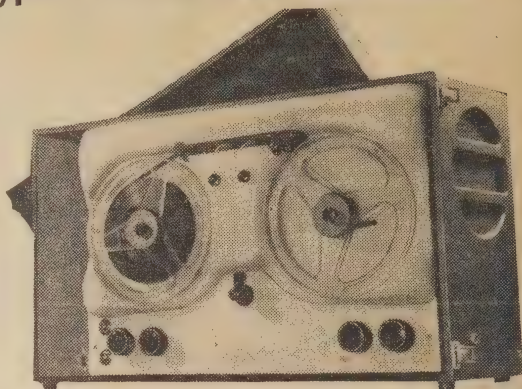
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extract from the electrical wave either of the original frequency components completely intact and to leave present only the other component—also completely intact!

Note that it has not been necessary to qualify any of these statements in terms of conditions (1), (2) or (3) above. They apply in all three cases. We can do nothing about (4) because no filters could separate components having the same frequency.

However, the important point is that no real combination of signals occurs in cases (1), (2) and (3) in our perfect set-up.

But let the speaker or the microphone, or the air-column or one of the associated amplifiers have a non-linear function, and inter-modulation immediately occurs between the two signals. Extracting the higher frequency signal would reveal upon it a modulation component belonging to the lower frequency. You see, the matter of linearity is absolutely vital.

THOSE EARS AGAIN

Now let's get back to our ears and remember that they have diaphragms and linkages just like microphones and speakers. When acted upon by sounds of different frequency, they follow a displacement curve which, neglecting imperfections of the system, are identical with the curves and behavior we've been talking about.

And here we come to the crux of the matter, on which the whole analysis must stand or fall. If our aural sense, as a whole, was perfectly efficient in its operation, we would hear the two (or more) incident sounds and invariably recognise them for what they were.

Our powers of selection and observation would automatically "filter" them out and we would conclude "... yes, there are two (or more) separate sounds there of such and such a pitch and amplitude."

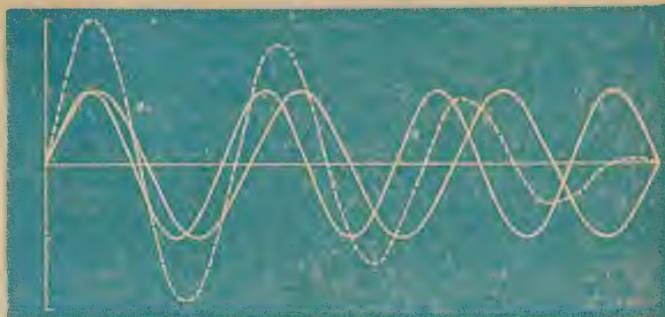
We already do this to a certain extent. However, the limitations of the ear are such that when its mechanical parts describe a slow rhythmic motion, which results from two incident sounds lying very close in frequency, our senses seize upon the rhythmic motion as the most important stimulus and relegate to the background the two original tones.

In other words, our senses inform us of a component which is additional to the original stimuli and which is not necessarily created by any external medium of transmission. To me, that looks very much like a non-linear function, even if it finds its explanation on the most intimate psychological plane.

OVERALL DISTINCTION

You will remember that, in the August issue, I was most careful to speak of "overall distortion in the aural sense." Quite a deal of distortion can be measured in the cochlea functions, but how much more can be traced to the brain functions I am not competent to say. I doubt whether anyone is!

It does seem, however, that we register pleasure on occasions when the addition of fundamental or partial tones, or the operation of some mechanical contrivance, creates a pulsation at a relatively slow rate. We describe such phenomena in terms of beats, vibrato, tremulant, vox humana, and so on. This goes for



This curve merely illustrates the summing action of two waves, as it affects a stylus point or diaphragm or an electrical circuit. Only when the dotted curve becomes a separate stimulus can a beat be said to exist.

frequencies up to about 20 cps.

When the addition produces a tone between about 20 and 50 cps—and particularly around 33 cps—we seldom like it. One of my text-books tells me that beats between fundamentals or partials which lie within this region are the basis of dissonance.

When the resultant is above about 50 cps we tend to regard it as a separate tone and it isn't necessarily displeasing. In fact, it can be quite the reverse. One of the arts of orchestration or organ playing, I am told, is to choose the instruments or stops so that you gain maximum effect from the addition of particular partials.

Our acoustic friends prefer apparently to call these "combination tones" and the term may be very useful quite apart from all the argument as to how they originate.

IS THIS THE ANSWER?

However, reading what I have just said and looking again at the correspondence, I'm rather impressed by Mr. McDermott's summing up... "It would seem that the shade of difference existing between beats and combination tones lies in the way in which they are detected by the inner ear."

Such a statement would tie in quite nicely the known distortions of the ear structure with possible psychological effects I have been talking about.

Just to round things off, let's look again at the diagram from which our friend W.G.S. draws certain conclusions.

Actually, there's nothing very special about it. Given enough paper and patience, you can add graphically any two waves, irrespective of their frequency or amplitude. In this case the result is sufficiently different to warrant a special name by some folks.

But it's of no use drawing diagrams showing how waves can add to produce something else unless you can also say where the phenomenon occurs.

If you insist that the constituent waves "add" in the air, or at the microphone, or in the transmission circuit, or in the loud-speaker, then you must be consistent. You must also agree that resultants are produced from the addition of all other frequencies which happen to be pre-

sent in the same place at the same time.

You see, you can't have it both ways. You can't have one group of frequencies adding to produce a resultant while denying other frequencies the same facility.

Let me remind you of a gramophone record, where the recording stylus draws in miniature the same kind of graph, plotting the instantaneous sum of a whole host of signals. Yet one of the tests for a recording system is to record selected frequencies simultaneously, then extract them separately from the pick-up output and demonstrate that there has been a minimum amount of intermodulation—in other words, no resultants, irrespective of frequency.

THE SAME THING

Fundamentally, our curve is the same thing as the wiggle in a record groove—a plot of displacement or of pressure at some point in space against time. The sum curve does not become a "beat" until conditions are introduced which allow it to emerge as a separate stimulus.

Finally, it is commonly stated that the resultant revealed by the diagram is a wave having the mean frequency of the original waves and modulated at the difference frequency. That is a half-truth!

The resultant is non-sinoidal, as will be apparent from the graph. And, anyway, you can't have a pure sine wave which is undergoing a progressive change in amplitude. In a sine wave the sections above and below the reference line must be identical, but they simply can't be identical if each half-wave is slightly larger or smaller than the one before it.

I must therefore seek leave to amend the usual text-book statement as follows:

"... the resultant is a non-sinoidal wave which is amplitude modulated at the difference frequency."

In fact, I'd like to say the same thing in another way:

"... the resultant is a wave whose amplitude is modulated at the difference frequency and whose wave-form is modified by the presence of a frequency or frequencies as yet unspecified."

Now, I believe we were looking for another possible frequency... Was it the sum...?



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SIMPLE MAGNETIC TAPE RECORDER

For those who are keen to begin practical work with magnetic recording, we publish this article by an English contributor. It uses DC bias and a single loop of wire or tape but it could be modified to use conventional spools. The construction of a simple magnetic head is also described.

By
G. R. JUDGE

MAGNETIC recording is now as firmly fixed in our lives as are radio and television, and any reader who cares to devote a few hours to the subject will get plenty of amusement apart from an insight into a very interesting scientific subject.

The simple mechanism shown in Fig. 1 will record short phrases, such as "sorry, no cigarettes," "Keep moving, please," "Queue along here," and so on; these phrases, once recorded, could be reproduced every few seconds for days, weeks or years, until the wire or tape itself had worn away.

ERASING

On the other hand, any recording made can be immediately removed from the wire or tape by feeding into the head an alternating current or by setting a small magnet alongside the loop so that, as the recording medium passes by the head, or magnet the magnetic flux erases any previous recording, thus preparing the loop for recording again. Such a device would be a boon to a person learning public speaking or plays; one could speak a line and hear it played back immediately, thus learning the quality or otherwise of the diction.

A few inches along the tape or wire from the recording head G would be placed the playback head H. The erasing head or magnet would then

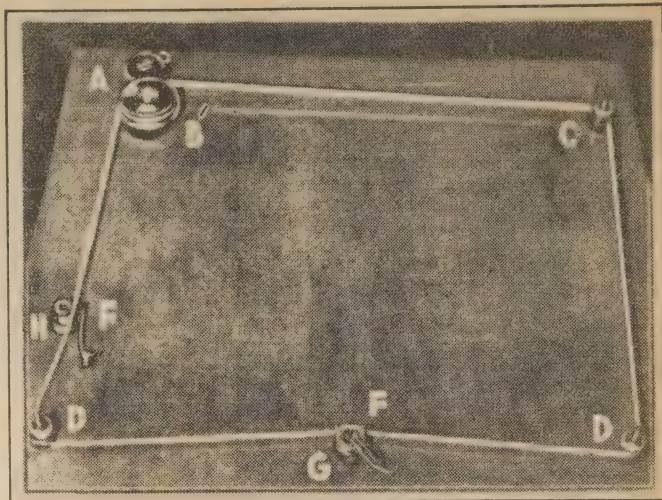


Fig. 1.—General view of the completed recorder.

speed of the tape or wire; if a gramophone motor is used which normally rotates at 78 rpm, by simple calculation it is possible to work out the correct diameter of the capstan.

Take a 3in capstan, for example: 3in multiplied by 3 1-7th (the accepted multiplicand for working out the circumference of a circle) will give you the circumference of the cap-

stan for tape, as quality improves with speed.

Around the capstan and the three corner rollers is placed a band of "Diamond" recording tape or of "Crown" recording wire, which ever you prefer to use. The capstan will drive this recording medium around, and to overcome possible slips a "pinch" wheel is arranged to press the medium on to the capstan.

This pinch wheel A is held on to the capstan by a tension spring, which doesn't show in the diagram as it is behind the board.

To keep the band of tape taut, one of the three corner rollers is not mounted directly on to the board; instead, the spindle of the roller passes through a slot in the board and is mounted into a strip of metal

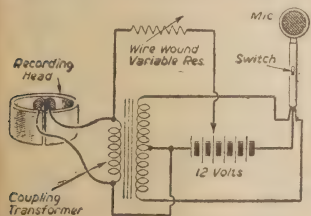


Fig. 2.—Push-pull, self-amplifying microphone, with D.C. biasing to the recording head.

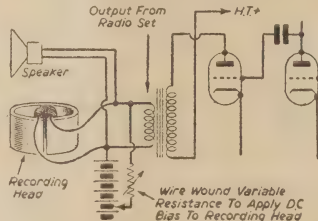


Fig. 3.—Utilising extension speaker sockets to feed the recording head.

be placed anywhere along the line between HBCDG.

Look again at Fig. 1. You will see a board, square in this case but any other shape will do as well, in the top left-hand corner of which is fitted a small electric motor. The motor used is a gramophone motor, but this is optional.

In place of the gramophone turntable is fitted a "capstan," the diameter of which must be taken into consideration when determining the

stan. Since the capstan will revolve 78 times per minute we multiply by 78 to get the total length travelled per minute. If we divide the result by 60 we shall then know the total length travelled per second.

Following these calculations, we find that a 3in capstan rotating at 78 rpm will have a perimeter speed of roughly 12in per second. Recorder manufacturers are satisfied with a speed of 7 1/4 in per second for tape, and 2ft per second for wire, so 12in should give us a little better quality

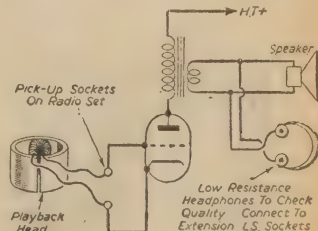


Fig. 4.—Method of using headphones for checking quality when using the playback head.



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the end of which is pinned to the board.

In this manner the spindle can move to left or right within the slot in the arm of metal. At the back of the board the strip of metal is held with a tension spring so that he roller is always trying to pull upwards, thus keeping the loop taut.

To join the two ends of the magnetic tape together a piece of self-adhesive selotape is used; the ends should be firmly joined with the adhesive on the glossy side, and any surplus adhesive should be neatly rimmed away to leave a smooth edge. The wire should be joined by notting carefully and trimming back the ends.

Fig. 1 (F) shows the recording head, and H in the same figure the playback head; the latter can be placed in any position, either close to or away from the recording head.

If you wish to record longer phrases it is suggested that you fit more pulleys, so that the wire or tape can zig-zag up and down the board, instead of just moving around the edge. Once you have the principle mastered, you can even fit up a recorder with spools of tape or wire.

To energise the head you can either use a self-amplifying microphone to record speech (Fig. 2), or if you wish to record a radio program or re-record a record for testing purposes you can connect the recording head to the extension speaker sockets of your radio, at the same time connecting a pick-up to the pick-up sockets (Fig. 3); when a record is played through the pick-up it will then be recorded on your wire or tape through your recording head.

USE OF RECORDINGS

It must be emphasised, however, that re-recordings made in this way are for private use only; performances in public, for whatever purposes, are an infringement of copyright and likely to be frowned upon by the owners of same.

For playback purposes one really needs a sensitive amplifier, as the amount of energy stored in the recording medium is quite small.

Although the stage gain of the domestic radio between pick-up sockets and output is not very great, one can overcome the difficulty by connecting headphones into the extension speaker sockets and connecting the playback head to pick-up sockets (Fig. 4). To get the playback louder at least a three-stage amplifier would be needed.

Recording and playback heads are quite easy to make. Referring to Fig. 1, you will notice a brass cup having a flange, which helps to fasten it down to the base-board. A is a piece of old felt hat forming a pad, B is a piece of spring (an old gramophone governor spring is suitable).

The felt pad lightly presses the tape T on to the gap C in the head. The winding on a strip of mumetal is shown at E, the two ends of the winding meet at C and pass through the wall of the brass cup so that the tape T can be made to slide across the ends of this mumetal strip.

THE GAP

A thin flake of mica D separates the two ends of the strip; this mica also passes through the wall of the cup, but its purpose is to keep the two ends of the mumetal strip no more

than a thousandth of an inch apart and thus form the magnetic "gap." What looks like sacking in Fig. 5 is the magnified grain of the bakelite board seen in Fig. 1, and the head shown in Fig. 5 is a magnified reproduction of that in Fig. 1.

If you have nothing in your junk box similar to the brass cup shown, cut off a piece of brass tubing about $\frac{1}{16}$ in diameter and $\frac{1}{4}$ in long. Slit this down one side and, with a well-cleaned and tinned hot soldering iron, thinly tin the inside and outside of the tube near the cut and also the two edges of the cut; this tinning should be as thin and smooth as the surface of a tin-plate can, so while the tube is still hot and the solder "wet" wipe it off with a piece of

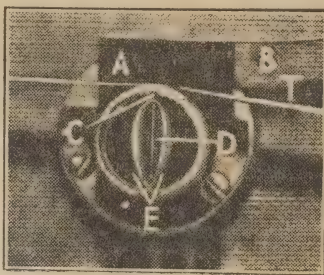


Fig. 5.—Enlarged detail of the playback head, showing the windings on the mumetal strip.

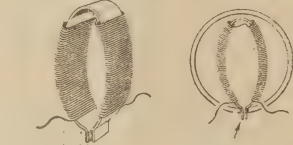
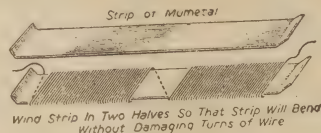


Fig. 6.—Method of winding and bending the mumetal strip, showing how the ends of the strip protrude through the slot in the brass tube.

rag to avoid any ridges or blisters of solder.

Next take a piece of mumetal 3-8 in wide and roughly $\frac{1}{16}$ in long — this metal is very expensive costing about 3/- per square inch, so to avoid spoiling it practise first with a piece of tin-plate. Mumetal, by the way, is the very opposite to a magnet; it will not retain magnetism.

Having cut your piece of metal to the right size, clean the edges with a fine file to remove all burrs, then thinly tin the ends for about $\frac{1}{16}$ in on both sides, once again making sure to wipe off all surplus solder while it is "wet."

With a pair of square-jawed pliers give a slight set to the ends so that if the strip is held upright and regarded on edge, with the sets to the

left, the top set will point at 11 o'clock and the bottom set at 7 o'clock. Now wrap the strip with two layers of selotape and wind on about 120 turns of 32-gauge wire; try to leave a space in the middle of the strip to allow for bending round into circle, winding the wire evenly on both sides of the space—in Fig. 5 E indicates the two half windings.

Having wound the strip, bend it to lemon shape (Fig 6) and place it within the brass tube so that the two ends which have been set at a slight angle poke through the slit in the tube, as in Fig. 6. The slit in the tube should push the two ends of mumetal together so that there is no gap discernible between them.

You can then push between the two ends a very thin flake of mica, making a gap of about one-thousandth of an inch between the two ends.

SOLDERING

When you are satisfied that all is ship-shape, apply a hot, tinned soldering iron (but without any extra solder) to the gap, so that the ends of the strip and the tinned tube fuse together. If the wound strip is left loose within the brass tube you will find it difficult to make any recordings, as the gap in the head will move and vary in size.

When the soldering is firm, file away any surplus metal, which will be the ends of the mumetal strip poking through the slit in the brass tube.

When you have filed these ends level with the tubing, well polish the tube at this spot with a fine metal polish until the surface is very smooth, as any roughness would soon scrape off the oxide coating on the recording tape.

If you have decided to use wire for recording, file a narrow channel in the tube and across the gap for the wire to run in.

This type of head will be a low impedance head and will need a step-up matching transformer to couple it to the impedance input of a valve which is high. Fortunately, there are plenty of small microphone transformers available quite cheaply.

For a temporary test where no microphone transformer is available a speaker transformer can be used.

LOW POWER

Not much power is needed for recording, so don't shout into the microphone. As an example, if you were trying to magnetise a needle, a 6 in. nail and a jemmy, the needle would need only a few ampere turns of wire in comparison with the jemmy.

Remember that in recording you are only trying to magnetise a few molecules of material a thousandth of an inch long (the width of the gap).

The fittings shown in Fig. 1 to the left of the head and below the tape, and between the head G and roller D, are bakelite sockets to which are connected the adjacent heads. To make connection one has only to plug in the relative plug, and arrangements are made for either recording or playing back.

Both the heads shown in Fig. 1 are made in exactly the same way, except that H was made in a brass cup and G in a piece of brass tube fitted between two pieces of brass plate.

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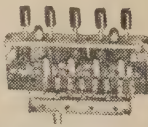
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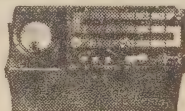
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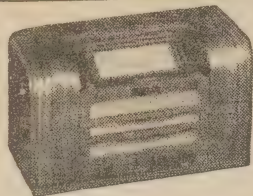
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ENLARGEMENT AND PERSPECTIVE

IN the days when grandfather was at the height of his enthusiasm over his "new science" the miniature camera as we know it today was virtually unheard of. Grandfather's equipment would probably consist of a whole-plate or half-plate monster, made of fine quality wood with brass fittings and complete with ground glass screen and black focusing cloth.

In addition to the camera itself, grandfather would take along on his photographic outings a batch of plateholders and, because of the size of the camera, a very substantial tripod. With all this gear to lug around it was not customary to carry a camera "just in case," as we do today, but rather to set a definite subject to be handled and treat as a major project.

PREPARATIONS

While the inconvenience of carrying all this gear was considerable, and there were no doubt many good pictures missed, things were not all on the debit side. The mere fact that a lot of preliminary work was needed, even when the selected site was reached, was in itself a restraining influence which discouraged indiscriminate pot-shooting.

The cost of the plates was also a factor to be reckoned with, and one may rest assured that grandfather went to a lot of trouble to ensure that everything was just as he wanted it before he finally exposed one—a procedure which many of us might well copy today.

When the negative was subsequently developed, the image was large enough to see at a glance whether it was good or bad. More important, it was large enough to make an acceptable print by contact. This is where present-day practice differs so markedly for, over the years, the emphasis has been on



Have you ever seen a cricket pitch as short as this? This effect—the short pitch which does not taper, and the constant size of the neat and distant figures—is characteristic of pictures taken with a telephoto lens or of a normal lens followed by excessive enlargement.

If one were to be asked what is the most significant single factor indicating the advance of photography in, say, the last 50 years one could probably reply, "The ever decreasing size of the average negative." In this article we discuss some of the problems of the small negative including the very vexed subject of perspective.

the reduction of camera sizes until today we may carry a camera almost without conscious effort.

But we have not achieved this convenience without some sacrifice, for the negative from a modern camera, while containing a wealth of detail, is so small as to be of little real value unless it is enlarged. This means greater outlay on equipment, more complicated processing, difficulty of retouching when required, and also of assessing the quality of the negative before an enlargement is actually made.

MINIATURE CAMERA

In spite of these problems there is no doubt that the miniature camera and enlarger are here to stay, for their advantages far outweigh their disadvantages and, in many cases, they are the only form of equipment which can be considered. This be-

ing the case, we may as well face up to the fact that, sooner or later, some form of enlarger will have to be obtained if really first class work is required.

This raises the question of just what constitutes a miniature camera or at what point in this negative-reduction business we must regard enlargement as inevitable. There have been many arbitrary standards adopted by which the miniature camera requirements show that any of the popular amateur negative sizes need to be enlarged for correct presentation.

Just why this is so may be better understood if we consider, in detail, the various reasons why enlargement is necessary at all, and these are listed as follows:—

1. The simple psychological effect that a large print is more impressive than a small one.
2. The need to make visible fine

detail which cannot be readily appreciated in a small print.

3. The need to correct distorted perspective.

4. The improved depth of focus which results from the combination of a short focus lens and an enlarged image when compared with a contact print of the same size from a long range focus lens.

The last mentioned factor may not be a strict reason why enlargement is necessary, but it is one of the advantages of the present day procedure of using a small camera with a short focus lens in conjunction with an enlarger, so that enlargement becomes essential if we are to use this advantage which has more or less been thrust upon us.

There is not much comment one can pass on the purely psychological reason why a large print is better than a small one, because it is diffi-

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cult to say just why this is so. It is quite likely that it is an unconscious reaction to the effects some, if not all, of the remaining factors.

BETTER DETAIL

Factor No. 2 is probably the most obvious one, for even the casual observer can appreciate that the large print contains detail which, though present, cannot be seen in a small contact. One major cause of this is that we cannot get close enough to the print to see it properly. The minimum distance to which the average human eye can focus with comfort is about 10 inches, and a print which is only a couple of inches square is not capable of revealing any fine detail when viewed at this distance.

Many people consider that the pictorial value of a picture is enhanced if it is printed on some form of rough surfaced paper, but if such a surface is used with a small contact print, the fine detail will be lost due to confusion with the paper texture. This is the reason why small prints are always made on smooth or glossy paper. When the print is large, it is possible to use the rougher surfaces because the fine detail is now bold enough to ride over the texture of the paper.

There is also the advantage that a large print may be more conveniently viewed by a number of people at one time, a factor which makes possible a more sociable presentation of ones favourite prints.

IMPORTANT DISTINCTION

Factor No. 3, perspective, probably causes more arguments than the ever popular "triodes versus pentodes." There is one school of thought which maintains that there is no such thing as perspective distortion and that a photograph is simply a portrayal of a scene as it would be viewed by the eye at the taking position. The opposition immediately produce a series of photographs which no one can deny contain the most horrible distortion imaginable, and which no one can remember having observed in real life. So the argument goes on.

The fact is that they are often arguing about two entirely different things and have failed to differentiate between perspective distortion and poor perspective. At the moment we are mainly concerned with perspective distortion, but this term is often wrongly applied to what is really poor perspective. It is important that we get these conditions clearly separated and defined before going any further.

Perspective distortion occurs when the picture presents to the eye a different image from that created by the original scene when viewed from the taking position. That is distortion pure and simple.

PERSPECTIVE

Poor perspective is more a pictorial matter and, assuming that there is no distortion, occurs when the taking position is ill-chosen. In this case the picture is a true representation of the scene as viewed from the taking position, but the taking position was a poor one pictorially, and careful observation of the scene would have revealed this before the picture was taken.

Anyway, what is perspective?

Well, we all know that as an object, say a person, moves farther away from us it appears to get



This diagram illustrates perspective distortion.

smaller, so that a person who is close to us appears larger than one who is farther away, even though we know that they are both the same height. That, simply stated, is perspective—the apparent difference in size of objects at different distances.

For purposes of discussion, let us assume that we have two persons of exactly the same size who will very obligingly move around and take up various positions as required.

Distortion of perspective occurs when something happens to alter the relative size of our two models, as, for example, when they are separated by a considerable distance and appear the same size (negative distortion), or when they are close together and appear vastly different in size (positive distortion).

This last one is the cause of the classic example where the subject is photographed lying on the grass with feet extended toward the camera, and the print shows a tiny head between two massive feet.

Now just what can cause this variation of our accepted ideas of relative sizes? First it must be appreciated that there is a second factor governing perspective, namely, the distance from the viewer to the objects.

As an example, suppose our two models are 30ft apart and you are only 10ft from the nearer one. Under these conditions the difference in their apparent size will be considerable. When you move off to a position some 250ft away, the difference will be negligible for, although both figures will appear much smaller, they will appear the same size, or near enough for all practical purposes.

If we now introduce an optical system which enlarges the distant image, it is possible to present the figures to the eye at a size equal to that created by the nearer figure when only 10ft away, but they no

longer have the difference in size which they should have for this distance.

The result is that they either appear closer together than they really are or, if the distance between them is made obvious, the distant one appears much larger than it should.

This effect is frequently noticed in newsreel shots which have been taken with a telephoto lens. In this case the telephoto lens produces the enlarged image of the distant scene, and it is not unusual to see cricketers at opposite ends of the pitch appearing the same size and giving the impression that the pitch is only about 6ft long.

Exactly the same effect can be obtained by excessive degrees of enlargement, particularly when we take a very small section of a negative and enlarge it to make a normal-size print. However, there are other limitations to high degrees of enlargement, and few amateurs possess a telephoto lens, so that this condition is not likely to cause a great deal of trouble.

RELATIVE SIZES

Positive distortion, on the other hand, is with us more frequently than we realise, it being only in extreme cases that the trouble is appreciated for what it is. Being the exact opposite of negative distortion it is brought about by the opposite conditions, or the reduction of the image size to the eye, which gives the impression that the subject is at a great distance, while the relative sizes are those one would expect when close up.

In this case our two models have been photographed close to the camera but at different distances, so that there is a considerable difference in their apparent size. When this picture is presented as a small print,

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EXCELAIR RADIO

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the size of the image on the eye is exactly the same as would be produced if the objects were much farther away from the viewing or taking point than was in fact the case. But although the size of the image has been reduced, it is not possible to alter the relative sizes, which remain as they were for a close subject, and this represents distortion.

That is a very general theory, but if we are going to make practical use of it we will have to consider some more concrete facts and figures concerning everyday practice. First point is the natural focusing characteristic of the human eye, which is such that it is very difficult to view a print closer than 10in, and this must be taken as a normal viewing distance.

Keeping this fact in mind, let us assume we photograph a scene with a camera having a 10in focal length lens. A contact print from this negative, when viewed at a distance of 10in, will present to the eye the original scene exactly as the eye would have seen it from the camera lens position.

Further, if a positive transparency were made, it would be possible to look through this at the original scene and, providing the distance from the eye was maintained at 10in, all points of the transparency could be made to correspond with all points of the original. Such a condition may be said to represent a complete freedom from perspective distortion.

VIEWING CONDITIONS

So far so good, but what happens when we use a 5in lens? A print from this will also present to the eye the original scene exactly as the eye would have seen it from the camera lens position, but only when viewed at a distance of 5in from the eye. Since the eye does not focus easily at this distance, the natural inclination is to view it at 10in—and so commences our perspective distortion.

However, this distortion vanishes as soon as we enlarge the image by two diameters, making the print suitable for viewing at a distance of 10in. This brings us to the whole crux of perspective distortion—that it is a function of viewing conditions rather than of taking conditions, and, if the image is correctly presented, there will be no perspective distortion. Putting it another way, the picture will be a true representation of the scene as viewed from the camera position.

The number of diameters of enlargement represents the factor by which any linear dimension of the negative is increased. Thus a negative image one inch long will be three inches long when enlarged three diameters.)

From the foregoing we may deduce a simple rule which will indicate the amount of enlargement required from any negative to produce a print free from perspective distortion. If we divide the normal viewing distance, 10 inches, by the focal length of the lens, in inches, the result will be the number of diameters of enlargement required for a distortion-free print.

Thus a negative made with a 2in lens, which is usual for a 35mm camera, will require to be enlarged 5 diameters. When a 3in lens is used, 3.3 diameters approximately will be required. Lesser degrees of enlargement than this will retain the

positive distortion and greater degrees will cause negative distortion.

All this assumes that the normal viewing distance will be 10 inches, but there seems to be some doubt as to whether this is always so. We made some tests among our fellow staff members and found that their first reaction was to work at something between 12 and 14 inches.

When they were asked to examine the photograph carefully for maximum detail they immediately brought the picture in to their best viewing distance, which averaged out very close to the theoretical 10 inches. The point is, however, that they did not do this as a matter of course and it would seem better to err on the side of greater rather than lesser enlargement.

In any case it must not be assumed that the calculated degree of enlargement must be rigidly adhered to and there are often many other factors equally as important which will dictate what the final amount will be. In many cases the distortion will not be noticeable as such, though it may well contribute to the general dislike of a print. Where the taking position has, perhaps of necessity, been one giving a poor perspective, the correct degree of enlargement may well be the difference between an acceptable print and one which is obviously distorted. Even though it does not strictly be-

long to a discussion on enlarging, we cannot pass this opportunity to comment on a frequent statement that short focal length lenses tend to produce perspective distortion. This statement is completely wrong for, as we have seen, a correct degree of enlargement will eliminate perspective distortion.

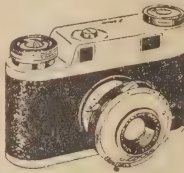
However, a short focus lens DOES encourage a taking position which has poor perspective, by encouraging a closer working position than would be possible with a longer one. For this reason one needs to exercise care in selecting the taking position to make sure that it is one which presents an acceptable picture.

As was intimated earlier, the increased depth of focus of the short focus lens can hardly be credited to the enlarger, except in so far as it makes the use of these lenses possible. Those of you who followed our discussion on lenses in the July issue will be able to appreciate why this increased depth occurs, but it is perhaps advisable to stress again the main points.

Assume that we take two photographs of the same subject, one with a short and one with a long focus lens and then make enlargements from both negatives so that both the final prints are the same size. Under these conditions it will be found that the print from the short lens will have the greater depth of focus.

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SHORT WAVE NOTES BY RAY SIMPSON

RADIO EIREANN—ATHLONE, IRELAND

Regular readers of these columns will remember that on more than one occasion we have made mention of the fact that there always seemed to be conflicting information concerning the Irish station Radio Eireann.

FLASHES FROM EVERYWHERE

WE have read in overseas journals that, despite the station's own statement, denying transmissions, listeners, including some in Eire itself, claimed definite reception.

As we have mentioned previously the 9.595 Mc outlet was heard out here at quite good strength around 7 am. But this was before the war, and since that time reports of reception have been few and in some cases rather indefinite.

However, it now appears that Radio Eireann is definitely on the air, as we have just received from Mr. Talbert, of St. Kilda, Victoria, a copy of a letter he received from the station confirming his reception on 17.84 Mc.

In fact, he kindly sent us the original letter and we quote in part as follows: "We are at present sending only news broadcasts on short wave. The transmitter works on 17.84 Mc power, is 1½ Kw and a rhombic antenna is used. Our plans for future short wave development are still under consideration and we are not in a position at the moment to say what form exactly our development program will take." The letter was signed by Mr. James A. Coyne.

The only operating times we know of are from 4.30 am to 4.50 am on 17.84 Mc, though an overseas report also lists them as transmitting on 11.76 Mc from 8.10 am to 8.30 am.

So that readers can watch for this station in the future we list all their short-wave channels, which are as follows: 6.19 Mc, 9.595 Mc, 11.74 Mc, 15.12 Mc and 17.84 Mc.

Note there is even a discrepancy here between the assigned frequency of 11.74 Mc and the 11.76 Mc mentioned above. According to the World Radio Handbook they open with the National Anthem, 'The Soldiers' Song' and the interval signal is the opening bars of O'Donnell Abu.

COMPLETE ENGLISH SCHEDULE RADIO MOSCOW

In the August issue we gave what we then knew to be the times at which English could be heard from Radio Moscow. Since publishing this information, we have received quite a few letters, some asking for further information. We have just heard from Mr. Talbert, enclosing copies of the latest schedule received from Radio Moscow.

There are nine main transmissions in English which are timed as follows:

1. 4.30 pm to 5 pm: 15.44, 15.36, 15.1, 11.63, 9.68 mc.
2. 5.30 pm to 6 pm: 15.44, 15.36, 11.63, 9.68 mc.

3. 2.30 pm to 3 pm: 15.36, 11.82, 11.63, 9.64 mc.

4. 3.30 pm to 4 pm: 15.36, 11.63, 9.64 mc.

5. 5 am to 5.30 am: 15.36, 11.63, 9.68, 9.67, 9.64 mc.

6. 5.30 am to 6 am: 15.36, 11.91, 11.63, 9.833, 9.64, 9.55 mc.

7. 6.30 am to 7 am: 15.36, 11.91, 11.63, 9.833, 9.68, 9.64, 9.6, 9.5 mc.

8. 7.30 am to 8 am: 15.36, 11.91, 11.63, 9.833, 9.64, 9.55 mc.

9. 8 am to 9 am: 15.36, 11.63, 9.64 mc.

- There are also programs in English beamed to the Far East and Europe at the following times:

- 6 pm to 6.30 pm: 17.81, 15.1, 11.78 mc.

- 7 pm to 8 pm: 17.81, 15.44, 15.36, 15.2, 15.1, 11.63, 11.78, 9.68 mc.

- 8.30 pm to 9 pm: 17.84, 17.81, 15.36, 15.41, 15.2, 11.78, 11.63, 9.58 mc.

- The programs for North America are on the air as follows, 11 pm to 11.30 pm:

- 17.83; 15.44, 15.2, 15.12, 11.96, 11.91, 11.63, 9.83 mc.

- 9.20 am to 10.30 am: 15.23, 15.18, 15.11, 11.91, 11.82, 11.81, 9.83, 9.67, 9.55 mc.

- 10.30 am to 11.30 am: 15.23, 15.18, 15.11, 11.82, 9.67 mc.

- 11.30 am to 2 pm: Same frequencies as from 9.20 am to 10.30 am.

- Programs beamed to the Pacific Coast:

- 2 pm to 4 pm: 17.81, 15.23, 15.18, 15.11, 11.82 mc.

- At noon on Sunday and Monday you can hear Moscow Mailbag, acknowledging letters from listeners, replying to the questions our listeners ask and ending with a request musical program.

SHORT WAVE NOTES for the December issue are due on November 10.

For the January issue they are due on December 8. Please send them direct to Mr. Ray Simpson, 80 Wilga Street, Concord West, NSW.

CZECHOSLOVAKIA: The Czechoslovakian short-wave station OLR3B has been heard recently opening at 4.30 pm on 9.504 Mc in parallel with OLR4C on 11.875 Mc, the program being in Italian. Signal strength was much better on the 25-metre band than it was on the 31-metre band but could be followed all right.

Prague has also been heard in the early morning over OLR2C and OLR3A, the former being on 6.01 Mc and the latter on 9.55 Mc. About the only thing which remains similar to the old days is their distinctive interval signal, which is a ready means of identifying the station. Some excellent music can be heard from Prague when conditions are suitable.

STATION ADDRESSES

- YXNQ Radio America, 2da Avenida Sureste 409, Managua, Nicaragua.
 YNEQ La Voz de la Victoria, Apartado No. 338, Managua, Nicaragua.
 XERQ Corporación Mexicana de Radio, Avenida Reforma 51, Mexico City D.F., Mexico.
 XEQQ Radio Panamerica XEQQ, Jose Maria Marroqui No. 11, Mexico City D.F., Mexico.
 4VBM Magloire Broadcasting Circuit, 36 Rue Americaine, Port-au-Prince, Haiti.
 4VRW Station de Radiodiffusion 4VRW, Rue Boun Fer, Box A117, Port-au-Prince, Haiti.
 CKLO Canadian Broadcasting Corporation, P.O. Box 7000, Montreal, Que., Canada.
 DZFM Radio Station DZFM, 4th Floor, City Hall, Manila, Philippines.
 ZBW3 Program Secretary, Radio Hong Kong, Electric House, 3 Connaught Road, Hong Kong.
 CR4AA Direcção do Radio Club de Cabo Verde, Praia, Cape Verde Islands.

YUGOSLAVIA: Radio Belgrade has been known to listeners for a very long time now, and during the past few months it has been heard quite well by new listeners in English given by a lady broadcast on 9.505 Mc at 3.45 pm. Recently this transmission has been discontinued on this frequency and is now given on 6.1 Mc, but unfortunately cannot be heard out here.

They are now broadcasting programs directed to Albania, Czechoslovakia, Greece, Poland, Spain, Bulgaria, Hungary, Rumania and the Soviet Union, and are on the air from 3 pm to 3.45 pm and 12.30 am to 7.30 pm. The program consists of music, news, Press reviews, commentaries, etc.

SYRIA: The transmissions from this country are now being heard quite well in the 16 metre band on 17.86 Mc and Mr. M. McShane, of Birchgrove, NSW reports particularly good signals till the stations close down at 1.45 am. According to the latest issue of the Universale their present schedule is as follows: To India and Pakistan 12.45 am to 1.45 am on 17.86 Mc; also in French from 8.30 am to 9.30 am on 11.915 Mc; 2.30 pm to 5 pm, 9.30 pm to 11 pm, 2 am to 7.30 am on 6.187 Mc; 2.30 pm to 5 pm, 7.30 pm to 11.30 pm, 1 midnight to 2 am, 2.15 am to 3.15 am, 3.30 am to 5 am on 9.555 Mc. On 17.865 Mc there is a program from 12.45 am to 1.45 am. On Sundays there is a program of 15.395 Mc from 7.30 pm to 9.30 pm.

TRANSJORDAN: This Middle Eastern station is not often mentioned in short wave news but it is interesting to note that the Hasemite Jordan Broadcasting station at Ramallah on 7.11 Mc is now on the air from 3 pm to 4 pm in Arabic, 9 pm to 9.30 pm in English, again in Arabic from 9.30 pm to 10.30 pm and in English from 11 pm to midnight. The final session is again in Arabic and is broadcast from midnight to 4.30 am.

On a favorable night this station can be logged just before midnight, and an aid to identification they announce in English "This is the Hasemite Jordan Broadcasting station calling from Jerusalem." They verify correct reports of reception, so it is quite worth while to take down some of their program.

GREECE: There are now quite a number of stations operating in Greece in addition to the National Broadcasting Institute. There is the Greek American station at Salonika, which is on the broadcast band only; then the autonomous station such as Athens University, also broadcast band only, Crete on 6.48 Mc and 7.12 Mc. The Army stations at Athens which use 6.34 Mc, Cavalla on 7.165 Mc and possibly the best known of these stations Jannina, which uses 6.2 Mc, and Larissa on 6.745 Mc.

Other lesser-known stations are Komotini on 6.4 Mc, Kozani on 7.95 Mc and Tripoli, which uses 7.01 Mc. Finally we have Salonika on broadcast band and also 7.06 Mc, and Makronissos on 7.03 Mc.

CHINA: Once again, thanks to Mr. McShane, of Birchgrove, we hear that Peiping Radio can be heard reasonably well in the 19-metre band both around 8 am and just before 8 pm, the latter being slightly better than the morning transmission. We understand that programs in English are given at 7.30 pm to 8 pm and 8 am to 8.30 am on 6.1, 10.26, 11.69, 15.06 and 15.17 Mc and from 11.30 pm to midnight on 11.69 Mc and 15.06 Mc.

There is also a transmission in Morse over station BAB on 8.105 Mc at 11 pm beamed to Europe, and another beamed to North America over station BAB2, which operates on 11.45 Mc at 10 pm. We have heard what we think are these broadcasts but did not hear the call letters transmitted.

THE AMATEUR BUREAU

The final decisions on the frequency allocations as generally decided upon at the Atlantic City Telecommunications Conference held in 1947, should soon be to hand as a result of a conference held in Berne during September.

THIS extraordinary administrative radio conference was originally planned to open at The Hague in September, 1950, but at the request of the US Government in view of the war position in Korea was postponed until this year.

The Swiss Amateur Radio Society, the USKA, have maintained a watching brief at the conference on behalf of the International Amateur Radio Union. The RSGB decided a delegate would be sent if the position at any stage warranted it. While ARRL secretary A. L. Budlong Wibud was unable to attend the ARRL's 1951 national convention held at Seattle as he was standing by in case of a call to Berne.

The main Atlantic City conference divided the frequency spectrum between the various services, aeronautic, amateur, broadcasting, &c., and special planning boards were set up in Geneva to arrange allocations of frequencies within the various bands.

It was originally believed that the task of The Hague (now Berne) conference would be to adopt, if satisfactory, the plans as arranged by the planning boards. It now appears, however, that several new schemes were to be submitted.

It is not anticipated that any of these new schemes will affect the proposed amateur allocations, but there is a remote possibility that the 3.5 Mc/s amateur band could be discussed. Certain European countries appear anxious to confine amateurs to a small exclusive band around 3.5 Mc/s rather than a wide shared allocation over the full band as it is at the moment.

If complications affecting amateur radio arise, delegates from both the ARRL and RSGB will attend and, providing there are no serious interruptions at the conference, we should shortly learn of the future of our new 21 Mc/s band and the more pleasant curtailment of both the 7 and 14 Mc/s allocations.

Some time ago mentioned in these columns was the fact that the Royal Air Force was forming a wireless reserve mainly for radio amateurs to provide a reservoir of trained operators in emergency.

Full details of the RAF Voluntary Radio Service are now available and a comprehensive scheme has been worked out to attract radio amateurs into the service.

The RAF is anxious to build up a reserve of male operators. The Voluntary Radio Service will comprise both Air Force and civilian personnel. The former are enlisted as personnel with a mobilisation liability in the RAF Volunteer Reserve. If amateurs for any reason cannot join as Air Force members they may volunteer their services as civilian members.

OFFICES

Officer appointments will also be made to amateurs suitably qualified. Officers are required with the rank of flight-lieutenant to run districts and will be responsible for the recruiting, training and the issuing of equipment to members.

All members will be required to undertake V/T reception duties in their own homes for 16 one-hour periods in each month and to attend meetings arranged by the officer I/C of the district.

A RAF receiver will be issued to each member, who should be qualified to receive Morse at 20 words per minute and be experienced in the operating and minor servicing of communication receivers.

Air Force members will receive an allowance of £3 annually for maintenance of equipment and £2 for expenses. They also will be eligible for a £7/10/- bounty and £1/10/- proficiency award.

Civilian members will receive 12-monthly allowance plus expenses. A car allowance is also payable to members travelling to meetings.

Enlistment of members is proceeding and a satisfactory response has been recorded to date.

The FCC have finalised their regulations concerning the erection of amateur antenna supports in the vicinity of airports. These regulations do not affect structures erected prior to February of this year, but future masts and towers will have to conform to the restrictions. There is a height allowance of lift for every 200ft the station is located away from the airport.

According to the regulations the maximum height permitted is 14ft at a half-mile or 54ft if you are located at a distance of two miles. If you desire to erect antenna supports in excess of these allowances special permission must be obtained from the FCC, and if such is granted obstruction lights have to be erected.

There is a general exemption provided, however, in case of antennas of limited height. A height limit of 20ft above the house or garage is allowed provided the mast is attached to such structure.

We should see some changes in American prefixes with the introduction of the novice class of licence. WN will be the prefix in continental America. In the possessions the K will be dropped from the prefix and W substituted as the first letter. Thus a novice licensee in Hawaii would use the call WH6XXX instead of the normal KH6XXX, or WP4XXX in lieu of KP4XXX in Puerto Rico.

The novice class of licence is valid for 12 months only, and after that period the holder must qualify for one of the higher classes of licences. If the novice is successful in such examination he would hold his novice call with only a change in the letters of the prefix, WN6XXX becoming W6XXX.

D/F ON 144 MC/S

For some time now there have been requests for information on suitable equipment for use on 144 Mc/s during searches for hidden transmitters during field-days. Little, if anything, has been published on the subject and to investigate the problem properly would mean months of work comparing various amateur transmitters, receivers and their associated problems.

In view of the forthcoming Woy Woy and Urunga 144 Mc/s hidden transmitter searches Harold Whyte, VK2AHA, and Jim Cowan, VK2ZC, both of Newcastle, were asked to divulge the reasons for their consistent wins in these types of events.

They have been kind enough to furnish the following hints to assist others in the entertaining searches for hidden transmitters:

They both point out there are no secrets attached to their successes but suggest you do three things.

First, buy the best type of receiver which you consider most suitable for your needs. It can be either a simple super-regenerative job or a superheterodyne.

Secondly, build a portable beam. A three-element array would possibly be better. They both use the first type, however.

When you have completed the above jobs get into the field and practice with your particular equipment. When you think you are proficient start practising again, as they both point out that only by consistent practice can you hope to really obtain the "feel" of your equipment.

The receiver must be fully shielded, batteries, too, must be placed in a separate container the battery leads and plugs must also be shielded.

Check the receiver close to a powerful transmitter and, if necessary, vary the shielding to ensure minimum pick-up without the antenna connected. Perhaps double shielding, extra bolts, or additional earth leads are required. To date un-

shielded headphone leads have caused no problems.

Excellent results have been obtained with a simple 954 super-regenerative detector and one audio stage. A more complicated superhet may be better, but as previously pointed out the proficiency of the operator is a much more important factor.

The antenna, either a three or four element parasitic array, should naturally be designed for maximum front to back ratio. A number of articles have appeared in QST from time to time showing element lengths and spacing for the above condition. Anyway, it is preferable that the antenna be carefully pruned to ensure the best results are obtained.

The feeder should be effectively shielded to avoid stray pick-up. Again it is necessary to spend a considerable amount of time to make sure the beam is operating correctly.

WHAT TO DO

Of their modus operandi—you must be prepared to home on the hidden transmitter, and within a few seconds of the hidden transmitter opening up you should have a good idea of the direction of the station. Never take cross-bearings. Firstly, you cannot afford the loss of time taking them and, secondly, if either of them are not accurate you have a false idea of the transmitter location.

It is preferable to use a split station condenser to tune the input stage of the receiver, as this will allow balanced antenna coupling. The antenna coil should be very loosely coupled to the centre of grid coil. The degree of coupling can be fixed during the receiver trials.

It is wise also to bypass the headphones for RF. The receiver used by VK2ZC comprises a 954 acorn super-regenerative detector and 6C5 audio. The filaments run from cycle cells and the plate supply is a 45-volt B battery.

On the subject of bearings, the line is taken on the null point. During the antenna checks, make sure you can observe good, sharp nulls close to the transmitter. This is very important in the field as the last few hundred yards of the search often cause the most worry. To obtain this condition the receiver shielding must, of course, be effective.

Always take a quick, maximum bearing before taking one on the null point. This is to check that you are not working off the ends of the beam, and, finally, never take bearings close to steep hill fronts. They will be amazing how well they can reflect, causing all kinds of complications.

Both Harold and Jim say the above covers all aspects of their D/F work. We do know, however, that both of them build very fine equipment and are systematic in their work.

Perhaps if we follow the above instructions some of us may be able to supply the opposition in 144 Mc/s transmitter searches to Hunter branch operators that has been sadly lacking during the last few years.

It is with deep regret we record the passing on Friday, September 28, of Percy Ferny, VK2HI.

The Wireless Institute of Australia was represented at the funeral by past-president Jim Corbin, VK2YC, and Dr. Leo McMahon, VK3AC.

Active since 1934, Percy operated on all bands from 3.5 to 23 Mc but was mainly on 14 Mc CW. Perhaps his main interest in amateur radio was the building of equipment—always beautifully constructed—not only for his own station but for many amateurs in Sydney who did not have the facilities for construction, or possibly the time.

He was always willing to help anyone with their construction problems.

VK2HI was assistant QSL officer of the

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NSW division of the WIA, and through the years has performed many jobs on behalf of the division. He was of a retiring nature and little was heard of his work, whether it be sending out the monthly bulletins, distributing tickets, sorting QST cards or building equipment for display at the last annual hamfest.

Percy followed the amateur code, and that fact alone endeared him to all who had the privilege of knowing him.

WIA NEWS

An interesting diversion from the normal run of technical lectures was presented at the September meeting of the NSW division. On this occasion old-timers mounted the rostrum to discuss the "good old days."

Jack Pike, VK2JP (1906), Harry Stowe, ex-VK2CX and VK2WI (1911) and Joe Reed, VK2JR (1919) gave an interesting insight into the trials of the early days of the hobby. On display were many pieces of equipment of ancient vintage brought along by the old-timers. They ranged from Marconi magnetic detectors to inductances many feet long and clearly indicated the amount of home-constructed equipment that was used in those times.

One item, an audio transformer, home-made, used a secondary of 60,000 turns of #14-gauge wire, a job that most present-day amateurs would not like to tackle. It wound on a core made from a kerosene tin!

Much of the discussion was in humorous vein and the presentation was appreciated by all present.

Election of officers for the Hunter branch resulted in the re-election of all office-bearers unopposed. President Lionel Swain, VK2CS, vice-president Bob Wilson, VK2AFS, and secretary-treasurer Varley Fitton, VK2SC. There was one slight change, retiring treasurer Bill Plant, VK2AMM suggested that the positions of secretary and treasurer be combined, and this was agreed to.

Next meeting of the Hunter branch will be held on Friday, 9th November, at the Technical College, Tighes Hill Newcastle. A lecture will be arranged.

The monthly meeting of NSW division will be held at Science House, Sydney on Friday, November 23.

Official permission has been received for an increase of power to 500 watts for official WIA station VK2WI with certain limitations covering the permit. This increase of power will be valuable in improving the service to country members, especially under adverse conditions, and for that matter it should improve the coverage around Sydney and the outer suburbs where skip interferes with reception.

FIELD DAY

Final arrangements for the NSW division's Woy Woy field day include entertainment to suit all-comers. It is the one occasion during the year when the Hunter branch and country members meet the Sydney gang.

Last year the event was an unqualified success and this year's field day should be just as successful.

The program is briefly as follows: Assembly at 11 am on Sunday, November 18, at the Masonic Hall, Woy Woy.

Movies, competitions, raffles until lunch—the prizes will be well worth winning. 2 pm to 3.30 pm, 3.5 and 144 Mc/s transmitter searches and all-band "scramble."

Cups will be presented to the winners of the transmitter searches.

4 pm to 5 pm, prize presentation, brandy and general meeting.

It is the field day of the year. Let Cec Hardman, VK2KR, know if you can come along. No prior booking necessary, and the usual refreshments will be available. Tickets will be on sale at Woy Woy and at the October general meeting.

Times for the Voice of America amateur radio broadcasts sponsored by the ARRL have again been changed. It is rather difficult to keep track of these changes as times have been and will be changed in the future to suit varying propagation conditions.

YOUR OPPORTUNITY

to join the world-wide ranks of amateur transmitters! The Wireless Institute of Australia holds regular classes in Sydney to assist Sydney and suburban enthusiasts to obtain their Amateur Operators Certificates of Proficiency.

Write for particulars to the Class Manager, W.I.A., Box 1734, G.P.O., Sydney.

RADIO AND HOBBIES FOR NOVEMBER, 1951

Eastern and Pacific services are now radiated at 1230 hours GMT Sundays in the 19, 25, 31 and 49 meter bands.

Latin American service at 0230 hours GMT Sundays on the 19, 25 and 31 meter bands and the European and Middle East service at 1915 and 2100 hours GMT Sun days on all bands from 13 to 49 meters.

All broadcasts are audible here at varying strengths and in case times are changed in the future the program is reviewed at 1900 hours EAST Sundays when a check can be made.

The headquarters of the ARRL are proceeding with their plan to obtain statistics on TVI and it's cure. Appeals have been made to amateurs all over the continent to supply details of work done on the subject.

Information is desired on the type of TV sets and channels affected. Sketches

are required of the location, showing distances to TV sets and details of type of pattern on TV tube, amateur equipment and band in use. Cures, if any, should be listed and a note made whether the TV servicemen is co-operative.

The ARRL directed the collection of this information and the publicising of useful data in QST.

In Great Britain the RSGB have taken the initiative in this matter and have published a special booklet—Television Interference—written by J W Mathews, G6LL, available at a cost of 2/-. It is the latest addition to the RSGB's series of technical booklets.

Written especially for the radio amateur, it covers all aspects of TVI and its cure, the suppression of ignition interference and an appendix giving details of 500 commercial television receivers, intermediate frequencies, &c.

RADIO TECHNICIANS!!

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Quiz

1. Neglecting end effect, calculate the length of a half wave aerial for operation on six megacycles.
2. Define the following:—(a) mutual conductance, (b) A.C. plate resistance, (c) amplification factor, (d) secondary emission.
3. A capacitor of 4 microfarads, connected across a 50 cycle supply, has a reactance of 796 ohms. What would be the reactance if the capacity was changed to 2 microfarads?
4. What, in meters per second, is the nominal speed at which radio waves travel?
5. What is the wavelength in meters of a signal frequency of 4 megacycles?
6. If a 6-megacycle transmitter increases frequency by 0.02%, what is the frequency increase in cycles?
7. If two coils, each having an inductance of 1 henry, are connected in parallel, what is the total inductance?
8. For what percentage of each input cycle does plate current flow in a class "B" amplifier?

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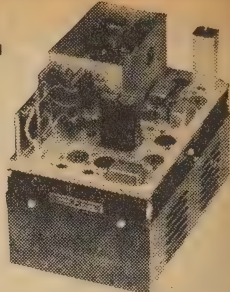
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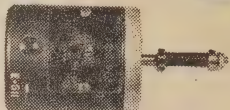
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479 PARRAMATTA RD., LEICHHARDT. PHONE LM3610.
AT TOP OF TAVERNER'S HILL

What is Electricity?

(Continued from Page 67)

There is something different about the two charges. The only conclusion left to us is that the charge on the glass rod is opposite to the charge on the plastic rule.

As a matter of convention, the charge on the rule is designated negative and that on the glass rod positive.

The experiment actually illustrates an important rule. When two bodies have the same charge of electricity they repel each other but when they have opposite charges of electricity they attract each other. Remember, like charges repel unlike charges attract. This is important because a similar rule applies to magnetic poles upon which we will learn later.

EBONITE

Incidentally, the same kind of charge as is produced by rubbing the plastic rule can be produced by rubbing a piece of ebonite, or more conveniently ebonite rod with a piece of flannel or woollen cloth. When these experiments are performed by physics students at technical colleges ebonite rod is usually used but we have found that the plastic rule works just as well or even better.

As a matter of interest, try rubbing copper, steel or some other metal rod and applying it to the electroscope. You will find that no matter how hard you rub you will not be able to give it a charge. You can see, therefore, that there is some fundamental difference between glass and plastic and the metal.

The difference is that the metal rods are conductors of electricity and is fast as you generate the electric charge it is conducted away through your body, which is also a conductor. Ebonite, plastic and glass are all good insulators and are able to hold on their surface the charge you generate by the rubbing action.

In the study of electricity it is important to know which substances are conductors and which substances are insulators. Certain substances are neither good conductors nor good insulators. Dry air is an excellent insulator otherwise it would have been impossible to perform all the experiments we have just detailed. However, damp air is a partial conductor and this is why the experiments do not work so well on a damp day.

CONDUCTORS

Of the conductors, silver is the best but copper is almost as good and, because it is relatively cheap and plentiful, it is used for most electrical wiring. Iron, tin, lead, aluminium and the other metals are quite good conductors, although not as good as silver and copper.

A complete list of insulators and conductors would be quite long and you would probably not remember them all at first reading, especially if you have not done any experiments with electricity previously. Don't worry too much about this point because you will learn to distinguish between conductors and insulators as you go along.

This month we have shown you how to generate what is known as static electricity and some of the effects of static electricity. On a smaller scale, this is the same type of electricity that causes the lightning flash.

You have also learned something of the significance of conductors and insulators. Conductors are used when

it is required to make electricity flow easily while insulators are required when it is desired to keep electricity in the one place. When you wish to transmit electricity from one place to another a convenient way is to use a conducting wire but to avoid waste, the conducting wire must be insulated away from all other conductors.

The electricity generated by rubbing the rule is very interesting from the point of view of experiment but since it is so small in amount, there are very few useful jobs it can do. If we wish to drive electric motors, light lamps &c. we need a steady flow of electricity rather than a sharp discharge that disappears in a fraction of a second.

There are lots of ways of generating a steady electric current and we will experiment with many of them as we progress. Batteries, such as you use in your torch, generate elec-

tricity from chemicals while the generator on a bicycle converts the mechanical energy from the wheel into electric current.

This month's experiments have probably done more to arouse your curiosity than answer your queries. You will still want to know what causes the spark and what causes the invisible attractive force of a charged object.

To give you a satisfactory answer to these questions we need to explain something about the structure of matter. The molecules and atoms that go to make up everything in the universe are so small that they cannot be seen with the most powerful microscope and yet on an understanding of them depends all our understanding of electrical phenomena.

It is a fascinating subject in itself. Next month, besides more interesting experiments we will tell you more about it.

TIME WON'T WAIT FOR YOU

(Continued from Page 15)

contacts are made and recorded on a moving tape mechanism.

When the star has almost reached the centre of the field of the telescope the instrument is completely reversed and the process repeated.

This reversal corrects any error there may have been in the alignment of the mechanical axis with the optical axis of the instrument.

The electrical contacts are being made all this time and at the same time one of the standard clocks has also been recording on the same tape.

Thus a record has been made of the time of transit of the particular star. This, however, is not an accurate record until certain corrections have been made for errors such as those of aberration, nutation, &c.

SIDEREAL TIME

By this means the amount of error of the standard clock is determined and Greenwich Mean Time is radioed all over the world for other nations to compare their own timepieces and for ships at sea to correct their chronometers.

The clocks used at the observatories give what is called sidereal time. This is the time taken between two successive transits of the same star and is the true period of the earth's rotation on its axis.

The duration of the sidereal day is 23 hours 56 minutes 4.09 seconds. The solar day is the time of transit of the sun. Because the transit of the sun varies in time, a mean is taken of these transits and this mean becomes the mean solar time standard used for civil purposes.

QUARTZ CLOCKS

In the observatory clocks giving solar time and others giving sidereal time are used. Greenwich Mean Time is based on the mean of these clocks. This is for the purpose of obtaining accuracy on days when it is not possible to take a transit because of bad weather conditions.

The greatest advance in timekeeping to date are the quartz crystal clocks now being installed at most observatories. These make use of the property of a crystal of quartz to oscillate at a fixed period according

to the way in which the plate is cut.

The quartz is cut to vibrate at a frequency of 100,000 cycles per second.

These vibrations are arranged to be fed into a circuit comprising various electronic tubes. An output is finally obtained at a certain reduced frequency and this is used to drive a synchronous motor which in turn drives suitable gearing and hands.

The crystals are kept at a constant temperature to within .01 degrees centigrade.

These clocks give an accuracy of one thousandth of a second per day and will in time replace the extremely accurate pendulum clocks hitherto used.

Thus are timekeeping errors being reduced to an almost irreducible minimum. Man is well on the way to becoming a mere machine governed by quartz crystals and thermionic valves.

G-Clamp Makes a Handy Camera Mount

A G-clamp fitted with two bolts forms an inexpensive "tripod" that can be mounted on a table top or the back of a chair. With a standard tripod head turned on either of the bolts, the clamp will hold the camera steady for portraits, time exposures and copy work, and is small enough so that it can be carried conveniently in the coat pocket.

OXALIC acid solution removes grease spots from leather. To clean grease spots from leather, first moisten the leather surface with water, using a wad of absorbent cotton or a small sponge. With another sponge, or a wad of cotton apply an Oxalic acid solution evenly over the soiled surface.

Make the solution by adding 1 part of oxalic acid powder or crystals to 10 parts of water.

After the spots have been removed with the oxalic acid, apply saddle soap to the leather and polish with a soft chamois or woollen cloth.

OFF THE RECORD — NEWS & REVIEWS

From a record player's point of view, the most interesting item in this month's issue is the article analysing the behavior of the popular GP20 crystal pickup on microgroove. Having managed to obtain a good frequency record for microgroove testing, we have been able for the first time to make some observations on pickup performance.

THE conclusions which have resulted are somewhat limited in their value as yet, because only a few pickups made for microgroove work have been available.

The story of the Acos pickup has been told so thoroughly by Mr. Williams in his article that I don't propose to go over the ground here. But I think we can draw some worthwhile opinions from the various curves having a bearing on reproduction classifications as a whole.

The first thing about pickups of this class is that they are extremely difficult to obtain with anything like a straight curve. Secondly, they are very hard to compensate to straighten out the inevitable peaks.

This, however, doesn't mean that they can't give good results.

By JOHN MOYLE

It does, I think, underline the fact that they will show up best with equipment of moderate range. Such equipment—and here I mean both amplifiers and loudspeakers, will tend to have a falling characteristic at the top end which compensates in a large degree for the unevenness of the pickup in that region. A little bit of de-emphasis such as might be afforded by use of a normal tone control is probably all that is needed to strike optimum balance.

There is no doubt that used in this way—and the vast majority of the pickups will be so used—results are very pleasing indeed.

If the full range of the records

is not being realised (and only the de-luxe jobs can honestly provide for this) we still appreciate the clean-cut nature of the LP records, their low surface noise, and generally high standard of reproduction.

We know quite a few people who are operating their amplifiers in this way and they are very happy with them.

COMPENSATION

Probably the best way to use this pickup is with the compensation circuit which reduces the output to about 100 millivolts—that is, to a figure comparable with that of a magnetic pickup. It can then be fed into one of our Playmaster amplifiers, for instance, under which conditions the compensation provided for various records will work out fairly well. The compensation circuit will reduce the importance of the main peak at about 5Kc, which otherwise can be somewhat noticeable, particularly on voices.

Such a setup is quite good, and even when used with a wide-range speaker will acquit itself well.

One commendable feature of the Acos is the suspension of the stylus. Not only is the compliance quite high, which is the same thing as saying that its resistance to side movement is small, but its protective prongs greatly reduce the danger from stylus or record damage in case of accidents.

The waveform from this pickup is particularly good over the entire range. Viewed on an oscilloscope no noticeable malformation of waveform can be detected until the very low frequencies are reached, where most pickups tend to become somewhat triangular due to the addition of harmonics. In this respect it appears the equal of almost any pickup we have tested to date, and, as might be expected, results in a very clean output.

WIDE-RANGE FIELD

Coming to the wide-range field, the picture at present isn't particularly encouraging as we are still waiting for new developments which are still only on the way.

Decca have announced pickup motor combinations which will shortly be on sale out here, but so far no plans have been made to sell the Decca pickup by itself.

This seems a pity, as past experience has shown that the Decca pickups have been of a good standard. So far we haven't had the opportunity to run tests with the new microgroove version.

The Goldring "Three-way" pickup is another we have checked for response. This is a very different type from the Acos in both construction and behaviour.

It is magnetic, of course, and the stylus is actually the armature. It is suspended by being pressed into a

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 (Turkey In The Straw; O Dem Golden Slippers)
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all block of plastic material, the block being drilled with a central hole for this purpose. Different styles are used for 78 and LP records. Being changed by a simple process of extraction and re-insertion.

The distance the stylus is pressed into the block has a marked influence on both output and compliance. The head is really a balanced armature type, with two magnetic gaps. When the stylus is pressed right home, it enters the end of both gaps, and as might be expected, gives its highest output. It is pressed only part way home, the lower gap does most of the work, and the output isn't as high. It is, however, quite high enough to work well with the Playmaster, and with any medium to high-gain amplifier.

When playing microgroove records, I have found it best not to insert the stylus too far into the head. A simple test will show that under these conditions, the compliance is quite high, and record wear reduced in consequence. Fully inserted, the suspension is a good deal stiffer, although I would hesitate to say that it would be too stiff. But there is little point in using a suspension stiffer than is necessary.

NO RESONANCE

The response from this pickup on microgroove is quite wide, and extends well up into the region above 10Kc. One feature of the pickup is that there appears to be no pronounced resonance within the audible range.

One generally finds with a magnetic pickup that there is a drop of a few db on the upper register followed by a rise to a peak, which, in good pickups, is neared 20Kc and 10Kc.

The Goldring, however, showed a general and gentle drop in top response above about 6-7Kc and no tendency to rise to a peak at least within the range up to 13 or 14Kc.

At the bottom end, response was about what one would expect, with slight rise due to arm resonance which, however, could not be called excessive, or anything like some plastic-armed pickups of the past.

The wave-form through the range was commendably clean, and a visual check showed very little distortion.

This pick-up, therefore, can be expected to give a smooth and wide response and is therefore suitable for wide-range amplifiers and speakers. Personally I like the plug-in head technique rather than the replaceable stylus, which might not stand up to constant use quite as well. However, this is a point which only experience can determine. In any case few heads can be obtained reasonably cheap should the need arise.

However, I am not concerned at the moment with comparisons, or assessments of mechanical features. I am concerned only with commenting on performance checks.

OP RESPONSE

The falling top response of the Goldring isn't enough to constitute a serious criticism. With a Playmaster control unit it might be well to use slightly smaller condensers in the top-cut circuits, with none at all for British 78 records. At any rate the pick-up sounds very clean and smooth in action, as would be expected from the curves.

I had some interesting times with the HMV 12A which, as you might

remember, is the head I have used as a guinea-pig for experiments of my own.

With the unit modified according to a recent article, I found that the resonance with a metalshanked stylus was lower than I had expected—about 7-8Kc although it was not more than about 5 or 6 db. Using an all-sapphire rod stylus the resonance went up as expected. I finished up by using an armature plate with the tip filed down as much as possible without actually ruining its strength, and with its height reduced about half.

The extremely high compliance obtained by removing nearly all the metal from the little centre plate proved to be the main reason why the resonance was lower than I wanted. I compromised therefore by filing two more semi-circular cut-outs between the original cut-outs and the needle chuck. This increased the compliance quite appreciably, but allowed the plate to be more efficiently damped by the small rubber sheet by reason of the amount of metal I left behind.

To avoid any chance of groove skating under these conditions, I removed some of the counterweighting to allow a stylus pressure of about 6 grams.

PERFORMANCE

The general performance of the pickup is now much improved, and its frequency curve almost a replica of that obtained in my earlier experiments with 78 records. Main resonance is now about 13Kc. It is almost flat from 1Kc down to 50 cycles, drops smoothly by about 24db at 3Kc stays there to 8Kc, and lifts through reference at about 10Kc. The rise to resonance is about 5db above reference.

I have not yet attempted to pad out this resonance, but when I do, the curve should be within about 3 db throughout the audible range, which is quite a good figure. The waveform is slightly malformed at one or two spots, but not seriously so.

The net result is the best overall performance I've managed to observe to date, but it is only right to say that a hand-tailored pickup of this kind isn't a fair comparison with any standard mass-produced job. There are one or two specially-made pickups in the higher priced class which would probably show up even better.

As the long playing business settles down to steady production, we should have some very interesting times checking over the results obtained from various equipments.

Sound is certainly a fascinating business if we don't lose our sense of proportion!



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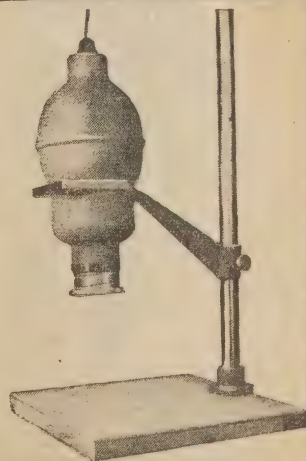
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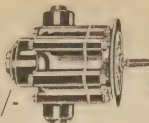
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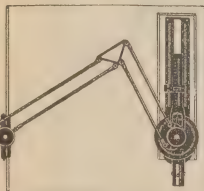


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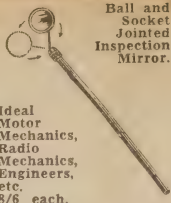
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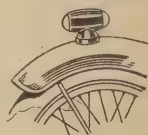
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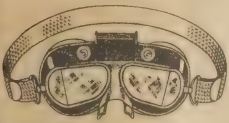
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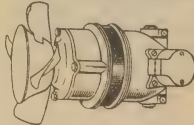
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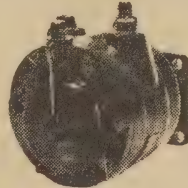


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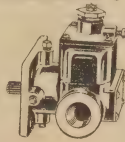
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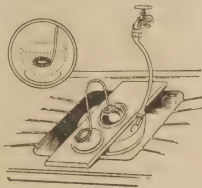
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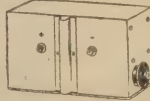
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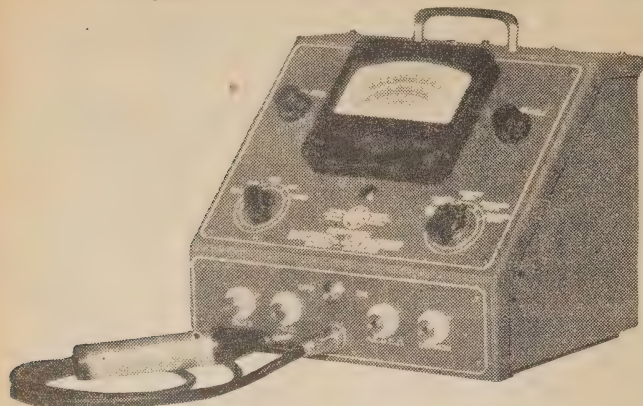
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NEAR LIVERPOOL ROAD. OPEN SATURDAY MORNING.

Serviceman Who Tells

(Continued from Page 63)

shadow angle with the set accurately tuned to the favorite station. Next time the popping and fading was observed, he was to note whether the shadow angle had changed.

What I was trying to find out was technically fairly simple. If the shadow angle remained unchanged, it was pretty clear indication that the gain of the set ahead of the detector was unaffected, thus indicating that the trouble was in the audio end. If the angle was affected, something was apparently happening in the high frequency section.

Next report was that the set had faded a couple of times and that the shadow angle had increased noticeably when this happened. Here was some tangible evidence.

On this score, I brought the set into the shop and gave it a thorough check to find (as I expected) nothing wrong that could possibly account for the trouble. I checked the voltages and the alignment, then let it run on the bench for days, without any sign of the fading. All I could do ultimately, was to return the chassis with the news that I could find nothing wrong. We'd have to keep trying!

Of course, it still might have been a local condition but the degree of fading described made this look unlikely.

TRIED OTHER VALVES

Well, to cut the story short, the set started its tricks again a little later and the owner duly reported to me. Well, we'd try a new approach. Here was a spare converter valve—he could plug it in and watch the set over the next few days. He did and it still gave trouble. It wasn't that valve!

Next we tried the IF amplifier—a diode-pentode—and this time we rang the bell. With the new tube in, the set worked well but with the old one, it returned to its nasty habits.

I'll never know the real cause of the trouble because I was very happy to sell the new tube and put the blunt edge of my cutters through the old one. (It wasn't due for replacement). Maybe the suppressor was adrift, or a diode plate. There may have been leakage across one of the micas or a spot of cathode material between here and there. The important point was that another darned "fader" had been fixed.

I think all intermittent faults should be obliged by law to yield to this Sherlock Holmes approach. They'd then be "elementary, my dear Watson."

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**PLAYBACK RECORDING
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BOX 5041Y, G.P.O., MELB., VIC.

ANSWERS TO CORRESPONDENTS

K.R.C. (Mona Vale, NSW) has built up the Fireside Five receiver using a 385-volt high-tension transformer and field coil type speaker instead of the 285-volt transformer and permanent magnet speaker originally specified. He finds that the set will not work and asks our advice.

A. The arrangement you are using is quite in order and, assuming the speaker and transformer are in order, would have no connection with the non-operation of the set. Other than this, there is nothing we can say to help you. If you care to write to us through the 1/- query service, giving further details, we will do our best to assist. In the meantime, have the valves checked and with the aid of a multimeter, systematically check through the set to make sure that all resistors, condensers and small components are in order. Finally, switch the set on and check high tension voltage and voltage at plates, screens, cathodes and grids of the various valves.

H.B. (Wondella, Q.) wants to know how to stop interference from the ignition system in a car radio, and asks if the electric petrol pump could cause interference.

A. Standard commercial practice is to fit a suppressor to the main HT lead from the coil to the distributor, and this should be located as close to the distributor as possible. Individual plugs are not normally fitted with suppressors. The main lead from the generator should be bypassed, at the generator, with suitable metal clad capacitors of about 5 mfd. The point on the LT system where the power is picked off for the set should be by-passed to the frame of the car in a similar manner. The lead from the aerial to the set should be shielded and, in addition, bonding the shield to the chassis of the set the other end should be bonded to the frame of the car at the base of the aerial. It is quite likely that the petrol pump will cause interference, but it is usually easy to pick this as it is normally a very low frequency, only occurring once in several seconds except when the ignition is first switched on when the reaction will be somewhat more rapid. Treatment is the same as for the generator. Electric clocks are another source of trouble and should be treated in a like manner.

C.P.H. (Elsternwick, Vic.) wants to know if he can fit pick-up terminals to the new Little General (1951).

A. It would be possible to fit a pick-up to this set, but because of the limited audio gain, only the highest output types (such as crystal) would be suitable. The existing volume control could be used for some form of switch, which would be required to change the connection from the F terminal of the IF transformer to the pick-up terminal. The remaining connection from the pick-up would go to chassis.

K.C. (Arimdale, NSW) wants to know if he can fit the new SLV21 dial, as used on the Little General for 1951, to a previous version of the Little General without having to purchase different components. The only way to fit this dial to the earlier type of the set, K.C., would be to set the dial forward from the chassis. The cabinet would still take this new arrangement. The alternative, of course, is to replace the standard-size two-section tuning gang with an M.S.P. (A.W.) miniature size two-section gang. Mount the dial flush with the front face of the chassis after making the necessary cut-outs in the chassis face to take the dial drive mechanism.

J.F. (Glen Oak, via Maitland, NSW) forwards his subscription for two years and expresses his general opinion of the magazine.

A. Many thanks for your remittance, J.F. It has been dealt with by the Editor, J.C. and the official receipt has, no doubt, been received by you. We are pleased to note your appreciation of the articles by "The Servicemen Who Tells." With reference to your query about the "Model Aeroplane Section," the fact is that we have not necessarily devoted a section of the magazine for exclusive use for model aeroplane information, rather it is that portion of the magazine has been allotted to a hobby

other than radio. It is true that in the past there has been rather consistent publication of model aeroplane information, but at the present time, this portion of the magazine has been taken up with a series of articles on photography. Unfortunately, available space in the magazine does not permit us to publish on all of the subjects that we would like and so it follows that one subject must be displaced for a period in favor of another.

V.S.W. (Caulfield, Vic.) asks if we have published any details on air compressors.

A. No, V.S.W., we have not described such an item. While a compressor is a very useful item to have around a workshop, its uses are more or less sharply defined. Further, the construction of such a piece of equipment is not normally within the facilities of the average hobby workshop fan. We would suggest that you pay a visit to the yards of second-hand dealers or the "junk heaps" of some garages and let your ingenuity run wild.

A.B. (Mackay, Q.) noted a query in these columns from a reader who wanted to convert his Christmas Box Menter to a switch-tuned set and forwarded comment upon his findings in constructing a switch-tuned TRF set.

YOUR QUERY?

1. Queries will be answered in rotation through the columns of our magazine if not accompanied by a fee for a postal reply.
2. Queries, neatly and concisely set out, will be answered by mail as quickly as possible if accompanied by 1/- in postal notes or postage stamps. Endorse envelope "Query."
3. Back numbers are rarely available but reprints of most circuits, wiring diagrams, and parts lists will be supplied for 6d each, minimum charge 1/-. Thus a circuit, layout, and parts list will cost 1/6 in stamps or a postal note. Endorse envelope "Circuit."
4. Blueprints of exact size chassis layouts with all essential holes, and cut-outs will be supplied if available for 2/6. Endorse envelope "Blueprint."

Address your letters to the Technical Editor, "Radio & Hobbies," Box 2728C GPO, Sydney.

A. Thanks for your letter, A.B. Your findings and observations are in keeping with our general views on the subject. There are good points and bad points in the scheme and it is generally necessary to effect a compromise between the requirements of the individual and the number of stations to be tuned in. However, apart from the special case of a remote-controlled motor-operated device, there is a lot in favor of the familiar push-button operated dial mechanism driving a conventional gang tuning capacitor. We have forwarded a copy of your letter to J.H.B. (Williamstown, Vic.) as suggested in your letter.

L.N.C. (Longwarry) wants to know if he can add an extra ohms range to the Radio and Hobbies Checka-Meter. He also expresses his appreciation of the Servicemen series and wants to know when another signal tracer circuit is to be published.

A. There is no reason why you should not fit the extra range, using the double pin jack and 148 ohm resistor as you suggested. Many thanks for your remarks about the Servicemen, and we are keeping in mind the need for a signal tracer.

I.A. (West Coburg, Vic.), in acknowledging our reply to a query raises the point of possible description of a simple valve tester.

A. We note the contents of your letter, I.A. We will look further into the matter to see what can be done, but have serious reservations about the practicability of the scheme.

D.V.W. (Christchurch, NZ) renews his subscription to Radio and Hobbies and asks questions regarding tape recording.

A. Many thanks for your subscription, D.V.W. We have been running a series of articles lately about tape recording and your questions will be answered by them more or less automatically. We do not think that tape recording and microgroove recording can fairly be compared on the basis of "which is best?" Both have definite advantages and limitations and the choice has to be made in the light of these and of your own requirements. We will doubtless publish circuits and data for tape recorder at some future date but are not hurrying unduly. We prefer to let things take their course so that readers will not be bustled into spending a lot of money on an item that has not been proven to be as reliable by actual use over a period.

J.P. (Hohora, Papua) sends in a further subscription and asks a query regarding crackle finish on metal parts.

A. We have passed your subscription on to the appropriate department and Radio and Hobbies will be posted to you direct until the January, 1955, issue. Crackle, or brocade finish as it is sometimes called, is best done with special paint made for the purpose in which case we should imagine that an ordinary oven would be suitable, provided it is capable of being maintained at an even temperature. We can supply a copy of the 1950 edition of the Shortwave Handbook direct from this office at a cost of 2/-, post free.

K.S. (Carlton, NSW) writes to ask the location of certain broadcast stations marked on the dial of his receiver.

A. As far as we know all the stations you mention are in New Zealand with the exception of 9PA which is in New Guinea. We should imagine that your best chance of receiving these stations would be after local and interstate stations have closed down. On this subject, you will find the "Answer Tom" article in this issue of assistance. We are very pleased to note that you find the "Learn While You Build" series interesting.

F.M. (Stockton, NSW) suggests a number of definitions for musical terms and also queries certain statements in the Popular Science quiz.

A. Many thanks for your comments and we would have reprinted the relevant portion of the letter had there been space to do so. We may yet do so at a later date but we feel that your suggested definitions would open he way to a lot of argument. Your comments re the tempering are in order but we cannot agree with the remainder of the letter. Except for the statement that "No energy remains in the weight while resting in its new position," your observations with regard to the energy of a falling body are correct. However, apparently you do not appreciate the idea of potential energy by virtue of position. While no energy remains in the body with respect to its new elevated position, it does possess energy with respect to the ground from which it was raised. This energy is equal to the work done against the weight of the body in raising it from the lower to the higher position. Furthermore, it can be proved that the sum of the potential and kinetic energies of a falling body is constant. For example, take the case of a stone falling from a 100ft tower. At the top of the tower the stone has a certain amount of potential energy in relation to the ground. If the stone is allowed to fall, at 50ft above the ground, it has lost half its potential energy but what it has lost in potential energy it has gained in kinetic energy. You can calculate the figure from the formula quoted in your letter. At the instant before the stone touches the ground all the potential energy the stone possessed at the top of the tower has been changed to kinetic energy. There is at no time a transformation of matter to energy. The mass of the stone is exactly the same before and after falling.

Readers say:

I thought you might be interested in a few impressions of television from this part of the world. I have been working on the design of television sets here and in England for the past 18 months and have reached a few conclusions.

I am quite sure we would be foolish to accept the 625 line international standards as they stand at present for our own proposed system. They have several drawbacks which I will mention later.

As these standards were drawn up mainly for the use of crowded areas such as Europe to facilitate the free interchange of programs, their main basis is hardly applicable in our case. From talks I have had here, I gather that Britain tried to have her present system adopted in toto without stressing the advantages of portions of it.

Firstly, the question of lines. From what I have seen, the 625 line system does give better detail than the 405 lines and is worth the extra bandwidth and its costs. FM sound is not such an asset. With the 25Kc's maximum deviation, the quality isn't much better than AM and at the frequencies we will be using microphony of the local oscillator is very much of a problem as far as FM sound is concerned.

Negative modulation, (peak white zero carrier and peak carrier at the tops of the sync pulses) is a very controversial question but my experience is that it is a lot easier to separate the sync pulses with the English system of positive modulation (i.e. peak white is peak carrier) and it is also less prone to disruption by ignition and other impulse forms of interference.

Compare the involved circuitry

and tubes needed in the average American set with that in an English set for sync. separation.

The main point brought up in favor of neg. mod. is that the noise shows black on the screen but this is more than offset by the effects of line raggedness and it is a simple problem to invert the noise and present it as black with positive mod. But the problem of line raggedness is very serious, as it restricts the definition much more than say a reduction in bandwidth.

A smaller point is the positions of the radiated sound carrier. As it makes the design of the IF section much easier it is almost standard practice now to operate with the sound IF at a lower frequency than the vision IF, and by having the sound carrier at a lower frequency than the vision carrier, the local oscillator can be operated at a lower frequency than either carrier thus improving the oscillator stability.

I know that some of my proposals would render it impossible to operate an "intercarrier" receiver, but it is my experience that this type of receiver is not very good, as if the carrier is cut off, at peaks of 100 pc modulation, then the mixing action in the second detector is interrupted and the sound has a "hole" punched in it.

This is quite prevalent in the present state of television and is known in the States as "intercarrier buzz." Rather annoying!

As I have been away from Australia for some time I am a bit out of touch with current affairs re television, but as we haven't yet started I am sure it would be worthwhile considering the above points before finally fixing our standards.

J. R. M. Allan.

A.C.R. (St. Peters, S.A.) writes to tell us of his interest in the "Let's Buy An Argument" feature, and to ask some queries regarding a proposed amplifier.

A.: Your kind remarks are very much appreciated and we trust that you will find future articles in the series equally interesting. In regard to the 2-valve broadcast receiver, it is possible that due to the use of the high-gain valve a certain amount of unintentional regeneration is present and accounts for the good results. The circuit constants associated with the 6SH7 and other details of the amplifier circuit appear to be in order. The overall gain should be a little low for the microphone but it may be adequate under close talking conditions. It is necessary to provide a shielded cable for the microphone and some form of

case for the microphone is desirable for mechanical reasons.

J.C.G. (Mitchell, Qld.) asks whether we know of anyone who has an 8mm camera and projector for sale.

A.: Sorry, J.C.G., but we cannot help you directly. Equipment of this type is on sale in second-hand camera stores in the capital cities, and you may get what you want by writing to one or other of them. Alternatively, you may care to insert an advertisement in the Wanted To Buy columns in the hope that some other reader may have for sale the type of equipment you require.

B. (Highbury, W.V.) is interested in the current Learn While You Build kit series, but would like to adapt the sets for operation from 22-43 volt mains.

A.: Many thanks for your subscription, and we are glad to note that you like the series. Unfortunately the AC mains receivers could not readily be converted for operation from a house lighting plant, and we cannot assist you in this regard. Sets designed for battery operation would have to be completely different from the present series.

G.F. (Melbourne) asks why he has heard stations 3KZ and 3DB on the short-wave bands in his set.

A.: There is just a chance that what you heard may have been a relay of a special program, but it is really unlikely. You do not state the coverage of your sets on the short waves, but if you happened to be listening on the band 100-200 metres, you may have heard a harmonic of the stations, particularly if they are fairly close to you. If, on the other hand, you were listening in the usual 16-50 metre channels, the possibility of receive-

ing a harmonic would be slight unless you were very close indeed to the stations. The more likely explanation would be a fault or a peculiarity in your set, and it is not likely that any simple change would change matters. If you know how to do so, it may be worth while to check on the alignment, making sure that the IF is set on 455 Kc. A serviceman with the necessary instruments could do this for you, of course, but you may not consider the trouble and expense justified.

J.A.N. (Dargo, Vic.) asks several questions about the reconditioning of a car battery.

A.: The job of reconditioning a car battery is almost as far out of our line as your earlier questions on refrigeration. The normal activities of our technical staff are re-directed to the design and description of radio equipment and we are quite only a general knowledge of all our subjects. We know how a car accumulates works, for example, but we would have to dig through various sources of information to find out about mixing and adding acids to the battery. If you would like to help you, we simply haven't the time to go looking for this kind of information unless it is to support a general article on a particular subject.

G. (Balladon) has been reading our On the Record feature and is interested whether the old-style cylinder records may not have certain features which have been overlooked with all the present emphasis on microgroove, &c.

A.: We do not think that the old records have much to recommend them on the principles involved in their operation. The hill-and-dale method of recording avoids some of the difficulties of one track encroaching on another, but it relies entirely on the force of gravity to make the stylus point track on the downward excursions. It is true also that the groove is of constant speed, but this is not of much help if the speed is at all times too slow for the required standard of recording. The speed must be related to the stylus and groove dimensions at all times, and it is probably true to say that the relationship is better, even under the worst conditions of microgroove, than it could be with conventional dimensions of the cylinder system. Even assuming that a constant-speed microgroove cylinder was used, the problem of duplicating in quantity would appear to be far more onerous than with a flat disc. We do not think there is much chance of the cylinders having been overlooked—they are simply outdated.

S.B. (Melbourne) is interested in the 4/5 valve super featured in the short-wave handbook but wants to know whether it can be used with the coil data published for the 2J7 Five. He has also a two-gang condenser which apparently has a capacitance of 100 mfd per section.

A.: Unless you know exactly what you are doing, you will probably get into strife trying to vary the design in the way you suggest. In the first place, the 100 mfd. condenser will give a tuning ratio of probably less than 2:1 when associated with the trimmers necessary for circuit alignment. This means that only a small portion of the high frequency end of the broadcast band will be covered, the lower frequency stations being missed out altogether.

Then again, data for plug-in coils designed for use with manual trimmers &c. does not take into account the capacitive loading of the pre-amplifier trimmers in the type of set you are considering. The chances are that you would miss altogether the amateur bands to which they are directed, unless trimmers were removed to compensate. Then there is the problem of tracking and padding to be considered. In brief, if you want broadcast coverage, as you apparently do, you must use a full-size gang condenser and preferably a commercial dual-wound type. If you want coverage of the short waves, with gang tuning and switching, your best plan would be to ask for coil details as derived for the Communications Nine. These can be supplied through the postal query service.

Incidentally, there should be a line between the X61M cathode pin and the junction of the two 0.1 mfd. condensers. The line failed to appear in the circuit and, if added, will automatically supply the proper screen and cathode by-pass circuits which you like, &c.

A.B.M. (Port Pirie, S.A.) says he has a pick-up, presumably a lightweight magnetic, together with a transformer which is loaded across the secondary with a resistor and condenser. He asks about


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the precise effect of using this transformer.

A.: It is some time since we did any work with the pick-up and transformer you apparently have on hand but the pick-up is one which will tend to give an inherently level output and will therefore do nothing to compensate the normal attenuation in recording. The transformer has a falling top response which is further accentuated by the action of the loading components.

The action of reducing the treble response improves the overall balance of the reproduction although the compensation is likely to be inaccurate by any means. The transformer also increases the available signal voltage, which allows the pick-up to excite directly the audio channel of a standard receiver. To get the best out of this type of pick-up, the idea is to discard the transformer altogether and feed the output of the pick-up directly into a compensating pre-amplifier such as the "Playmaster" control unit. If the speaker is a wide-range type would also be worthwhile installing an absorption circuit to smooth out the peak which this type of pick-up exhibits in the region of 9 Kc.

D.B.W. (Melbourne) comments on the photographic article in the October issue.

A.: Many thanks for your letter and for the points you raise in relation to the article. We will have Mr. Watson reply to you personally by mail as soon as he returns from annual leave.

R.F. (Canley Vale, NSW) says he has a commercial mantle set which gives a rather thin tone. He wonders whether the provision of some other type of baffle would improve matters.

A.: Provided the present baffle board seals the area around the speaker housing and fits snugly against the cabinet grille, we do not think you would notice the difference merely from changing the

HERE'S YOUR ANSWER TOM

(Continued from Page 39)

is available, but the special 72 ohm transmission line made for his purpose is more efficient. For best results the receiver should be fitted with special doublet terminals, but if these are not available you could try connecting one side of the twin lead to the aerial terminal and the other side to the earth terminal, together with the earth lead. This is not an ideal arrangement, but it is often acceptable in practice where it is not convenient to modify the receiver.

A correctly-adjusted transmission line does not pick up any radio energy. This is an advantage in cases where there is severe interference close to the set, such as a vacuum cleaner or egg-beater in the same house. The aerial can then be placed as far as possible from the interference, resulting in an improvement in the ratio of signal to interference. Of course, if the interference is coming from a long distance, this is not likely to be of much advantage. The old adage, the proof of the pudding is in the eating, is particularly applicable in the case of aereals, Tom, so we suggest you try one or two simple experiments and see what happens.

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material—from wood to caneite, &c. It is fundamentally impossible to get good bass response from a small set because the cabinet simply does not provide sufficient baffling. Most small sets have a substantial by-pass between the output plate and B-plus to reduce the treble response and give a better overall balance. This may have been omitted in your set and be responsible for the effect you complain of.

F.R.D. (Orange, NSW) is interested in getting the best possible reception from distant broadcast stations and wonders whether it would be worthwhile erecting one of the "cage" aereals which were popular in the old days.

A.: As far as we know, the idea would be a complete waste of time. Ideally, the aerial should be as high as possible and be used with a direct lead in and an effective earth. It may be as long as 100ft, although too long an aerial may tend to load the aerial coil heavily and offset any advantage it might otherwise give. Receiver aerial coils are normally designed with a certain length of aerial in mind and the coupling is not optimum for very long or very short aereals.

The wire used in an aerial system appears to be singularly uncritical, however. We recollect some experiments conducted by an English writer who took readings of results from a given type of aerial erected with everything from an elaborate "cage" structure to a very thin strand of resistance wire. The differences were very small. The important thing is therefore to get the aerial well out in the clear and as high as possible. The best wire to use is a function of what you can get cheaply and is yet strong enough to remain in the sky, birds and wind notwithstanding!

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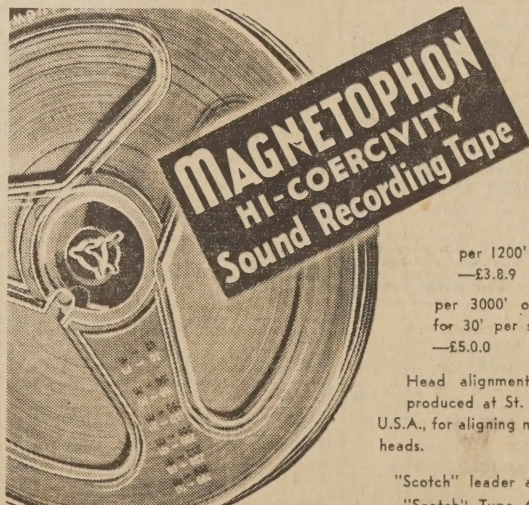
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